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FINAL

Interim Corrective Measures Work Plan for the Expanded Bioventing System Eglin Main Base Old Fire Training Area

Eglin Air Force Base
Florida

Prepared For

Air Force Center for Environmental Excellence
Technology Transfer Division
Brooks Air Force Base
San Antonio, Texas

and

AFDTC / EMR
Eglin Air Force Base
Florida

December 1997

726876/cov1297

PARSONS ENGINEERING SCIENCE, INC.

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FINAL

INTERIM CORRECTIVE MEASURES WORK PLAN FOR AN EXPANDED BIOVENTING SYSTEM AT EGLIN MAIN BASE OLD FIRE TRAINING AREA, SITE FT-28 EGLIN AIR FORCE BASE, FLORIDA

PREPARED FOR

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE, TEXAS
AND
AFDTC/EMR
EGLIN AIR FORCE BASE, FLORIDA

SUBMITTED TO

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IV
AND
STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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December 1997

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This interim corrective measures work plan (ICM work plan) presents the scope for an expanded bioventing system for *in situ* treatment of fuel-contaminated soils at the Eglin Main Base Old Fire Training Area (old Eglin FTA) at Eglin Air Force Base (AFB), Florida. This site is also identified as Installation Restoration Program (IRP) Site FT-28. The proposed expanded system activities will be performed by Parsons Engineering Science, Inc. (Parsons ES) [formerly Engineering-Science, Inc. (ES)] for the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under Contract No. F41624-92-D-8036, Delivery Order No. 0017. The primary objectives of the bioventing system upgrade are to:

- Provide aerobic *in situ* remediation of fuel-contaminated soils by injection of atmospheric air into soil;
- Sustain aerobic *in situ* biodegradation to reduce the concentration of hydrocarbons in the soils within the unsaturated zone beneath the site; and
- Provide additional site characterization data toward closure.

An extended bioventing pilot test was performed at the old Eglin FTA by Parsons ES from July 1994 through July 1995 to determine if *in situ* bioventing would be a feasible cleanup technology for the fuel-contaminated soils within the unsaturated zone. A radius of oxygen influence of at least 40 feet was observed at the site. Further details on the pilot test procedures and results can be found in the Interim Pilot Test Results Report (ES, 1994).

Following the extended pilot test, soil and soil gas data confirmed significant contaminant degradation in the pilot test area. Based on laboratory results from soil and soil gas samples, significant reductions in total volatile hydrocarbons (TVH), and benzene, toluene, ethylbenzene, and xylenes (BTEX) were observed in soil gas, and significant reductions in total recoverable petroleum hydrocarbon (TRPH) were observed in 2 of 3 soil samples. The soil sample collected from a depth of 3 to 5 feet below land surface (bls) from the vent well (VW) showed an increase in TRPH, however, this can be attributed to the inherent variability of discrete *in situ* soil sampling. More credence is afforded to reductions in BTEX concentrations since these compounds are preferentially biodegraded over TRPH. Significant reductions in BTEX concentrations were observed for all soil samples over the extended pilot test period. In addition, the extended pilot test demonstrated that significant oxygen utilization and biodegradation are continuing at the pilot test locations, and that continued bioventing will sustain the biodegradation. Further details on the pilot test results are presented in Section 3. The success of bioventing at this site supports the recommendation of an expanded (full-scale) bioventing system as

the most economical approach of remediating the remaining hydrocarbon-contaminated soils in the vicinity of the old Eglin FTA.

This ICM work plan addresses soil contamination associated with former burning of waste fuel, water- and solvent-contaminated fuel, waste oil, and virgin JP-4 fuel at the old Eglin FTA. Site investigation data collected to date indicate that the soil contamination exists from near the surface extending to the top of the water table (approximately 40 feet bls). The sources of contamination are the burn pit (approximately 75 feet in diameter) and a former unlined above ground storage tank (AST) area. Available historical data indicate minimal contamination in the surface soil extends beyond the perimeter of the burn pit. However, fuel-related contamination extends throughout much of the subsurface to the water table in the vicinity of the former AST located approximately 225 feet south/southwest of the primary burn pit. The proposed expansion of the bioventing system will provide oxygen to all contaminated soil to facilitate biodegradation of petroleum hydrocarbons.

Pilot test data have been used to design the expanded bioventing system to remediate contaminated soils. The expanded system will consist of the existing air injection VW, four new VWs, and an existing shallow monitoring well to deliver oxygen throughout the remaining unsaturated fuel-contaminated soils. Three new vapor monitoring points (MPs) will also be constructed to monitor contaminant reduction and oxygen influence in the soil gas. The expanded bioventing system will target vadose zone contamination including contamination in the smear zone.

This document is divided into eight sections including this introduction, and one appendix. Section 2 discusses site background and includes a discussion of existing site characterization data. Section 3 provides the results of the extended pilot test conducted at the old Eglin FTA. Section 4 identifies the treatment area of the proposed expanded system; provides construction details of the expanded system; and recommends a proven, cost-effective approach for the remediation of the remaining hydrocarbon-contaminated soils at the site. Procedures for handling investigation-derived waste are described in Section 5, and Base support requirements are listed in Section 6. Section 7 provides key points of contact at Eglin AFB, AFCEE, and Parsons ES; and Section 8 provides the references cited in this document. A design package for the expanded bioventing system is provided in Appendix A. Appendix B contains well construction diagrams for select site monitoring wells. The Extended Bioventing Program Health and Safety Plan and the Site-Specific Health and Safety Plan Addendum are provided in Appendices C and D, respectively. Design calculations are provided in Appendix E.

2. SITE BACKGROUND

2.1 SITE LOCATION

The old Eglin FTA is located in southeastern Okaloosa County, west of the north-south runway and north of Taxiway Number 6 within the main base of Eglin AFB. To reach the FTA from the west gate of Eglin Main Base (intersection of State Route 397 and State Route 189), proceed approximately 1 mile along Eglin Boulevard. Turn left (northwest) onto West Side Road and follow for approximately 1.5 miles to Tactical Air Command (TAC) gate. Turn right (north) onto the perimeter road and follow for approximately 2.25 miles past the ammo storage area. Take the first right (south) after encountering the ammo storage area on the left. Follow this road for approximately 0.75 mile and the road will terminate at the site (Figure 2.1).

2.2 SITE DESCRIPTION

The old Eglin FTA is defined by a large, circular area clear of vegetation, approximately 300 feet across covered by a clay surface (Figure 2.2). The training area is surrounded by an earthen berm measuring less than 12 inches high. The burn pit (located in the center of the training area) is currently inactive and measures approximately 75 feet in diameter with a partially intact 6-inch earthen berm along the periphery for fuel containment. No subsurface liner exists to collect residual fuels, water, and AFFF (an extinguishing agent) used at the site. Two smaller burn areas are located to the northwest of the primary burn area and outside the clay apron. These two areas are on opposite sides of the access road. The westernmost area consists of a collection of old burn drums. The second area is approximately 100 feet east of Building No. 910 and has been used for mixing molten metal fragments and miscellaneous burn debris with surface soil. The remnants of a former AST and unlined containment area are located approximately 225 feet south/southwest of the primary burn pit.

2.3 OPERATIONAL HISTORY

The old Eglin FTA site was used for the training of personnel in the suppression of fires associated with aircraft accidents. The site was active from the 1950s to the late 1970s or early 1980s. During the 1950s and 1960s, a variety of flammable liquids including waste fuel, waste oil, and contaminated fuel were used for fires. Training exercises were conducted as frequently as two to three fires per week. Due to pollution concerns in early 1970s, training exercises became less frequent and the quantities and types of fuels used were reduced.

Figure 2.1

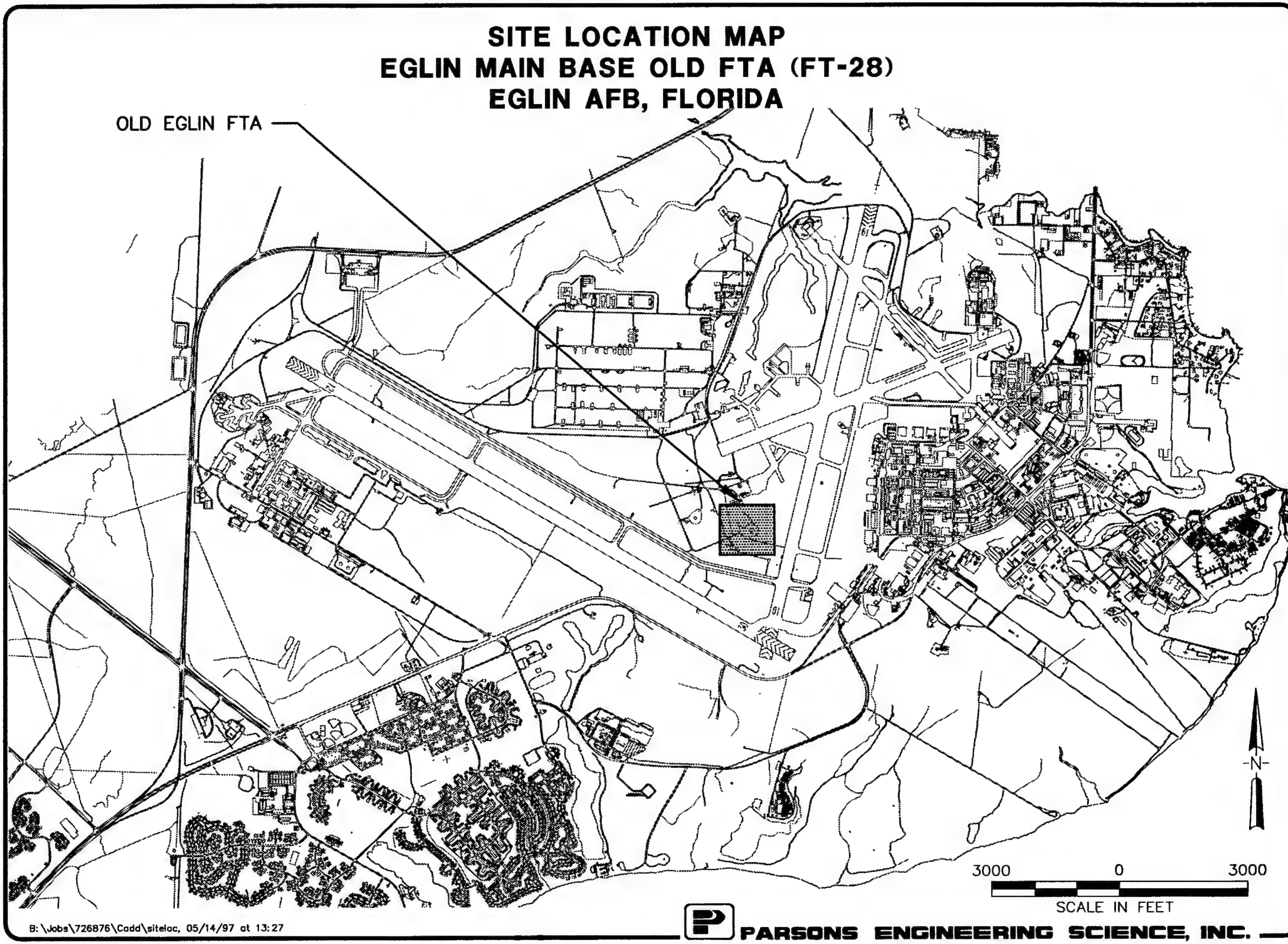
SITE LOCATION MAP
EGLIN MAIN BASE OLD FTA (FT-28)
EGLIN AFB, FLORIDA
OLD EGLIN FTA
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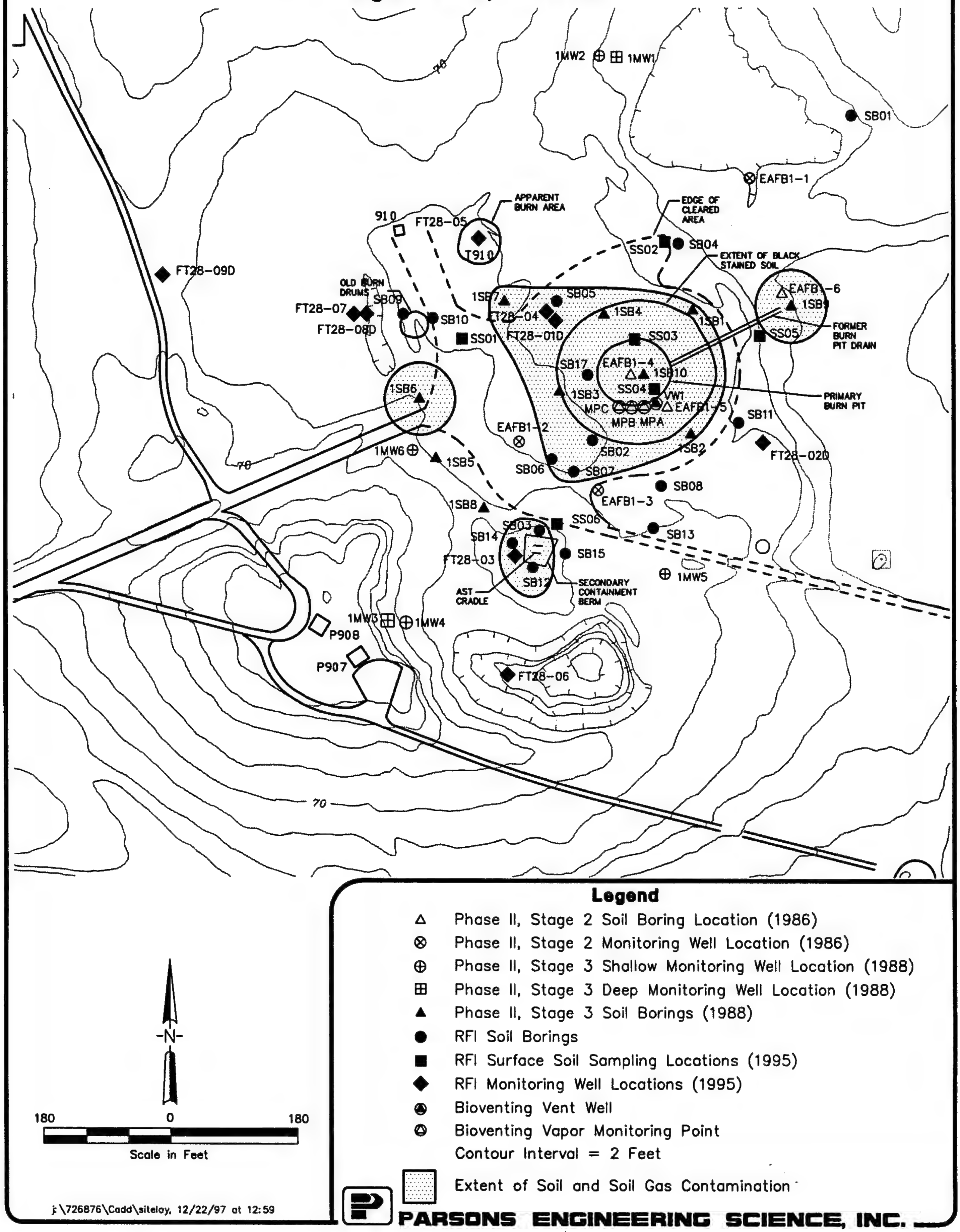
Figure 2.2

Site Layout Map
Eglin Main Base Old FTA (FT-28)
Eglin AFB, Florida



The common practice used during training exercises involved transferring flammable liquids to the burn pit via tanker truck or buried pipe from the AST. The flammable liquid was then sprayed onto a representative mock plane located in the center of the burn pit. Since the burn pit was equipped with an earthen berm, much of the fuel remained confined and was easily ignited. After a specified time, chemicals (AFFF and/or water) were applied to extinguish the fire. Any residual fuel flowed through a buried drain pipe to a small unlined depression east of the training area and was allowed to seep into the soil or evaporate.

2.4 SITE GEOLOGY AND HYDROGEOLOGY

Three predominant geologic features underlie the old Eglin FTA: the sand-and-gravel aquifer, the Pensacola Clay formation, and the limestones comprising the Floridan aquifer system. The surficial sands and gravels extend to an approximate depth of 100 feet bls. The underlying Pensacola Clay is approximately 400 feet thick in the area and extends to a depth of approximately 500 feet bls (O'Brien & Gere, 1995). Groundwater is encountered at seasonally fluctuating depths of approximately 38 to 47 feet bls.

Soils at this site, to a depth of 100 feet bls, consist of predominantly unconsolidated, subrounded, poorly sorted, very fine to very coarse grained quartz sand which becomes finer grained with increasing depth from the land surface (O'Brien & Gere, 1995). During installation of the bioventing VW and MPs, poorly to well graded sand containing intermittent traces of silt and gravel was encountered throughout the unsaturated zone to the top of the water table (approximately 39 feet bls). The generally homogeneous, sandy material at this site is well suited to bioventing treatment, as was demonstrated during the initial 1-year bioventing pilot test.

The sand-and-gravel aquifer occurs under unconfined or water table conditions at the site. The generalized groundwater flow direction in the surficial aquifer is radially outward between north and southwest from the primary burn pit as indicated by past groundwater levels in monitoring wells at the site (O'Brien & Gere, 1995). Near the former AST area, shallow groundwater flow is generally to the southwest. A hydrogeologic cross section of the upper 50 feet of subsurface soils and inferred extent of soil and soil gas contamination at the old Eglin FTA is depicted in Figure 2.3.

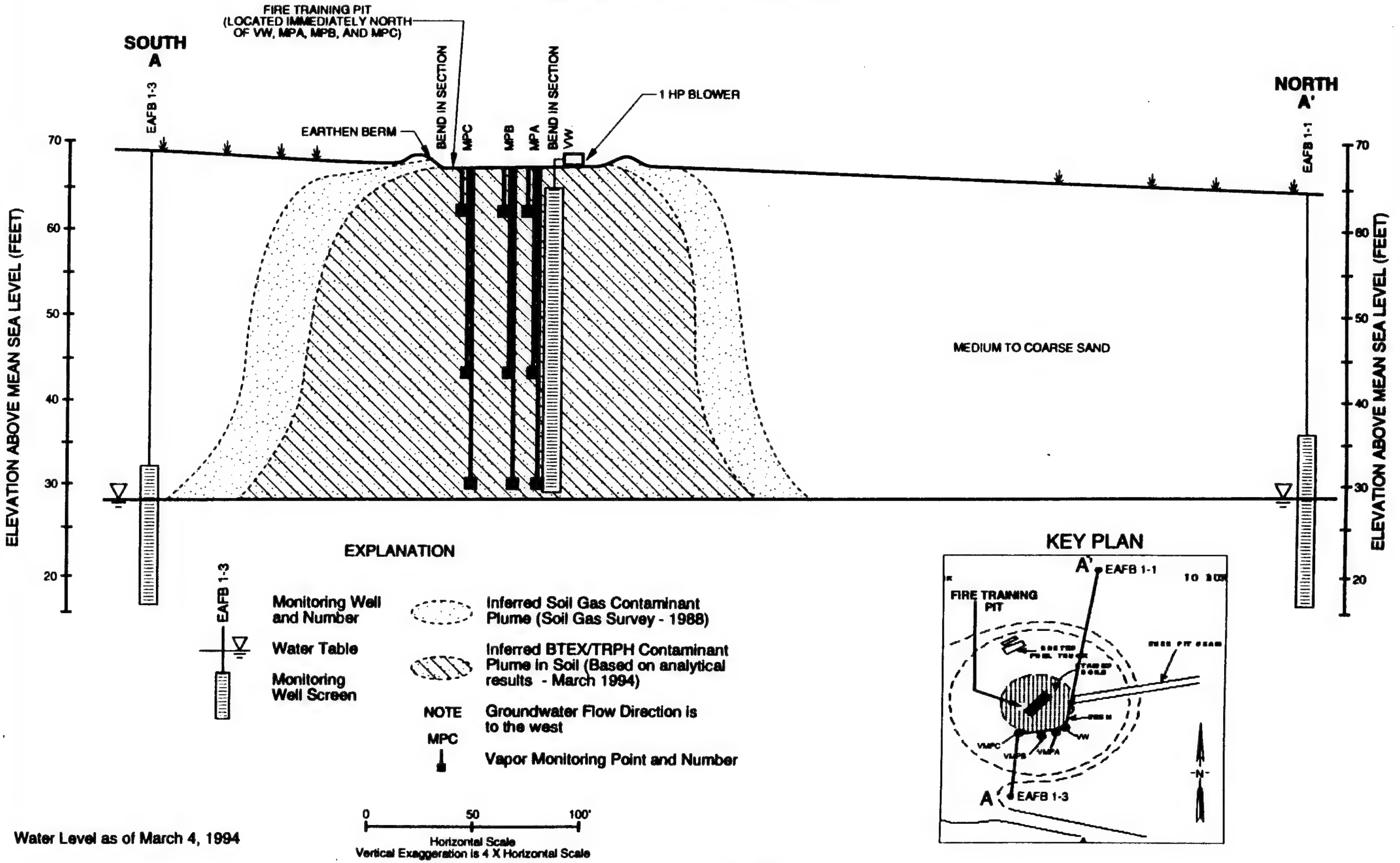
2.5 PREVIOUS INVESTIGATIONS

2.5.1 IRP Phase I Investigation

The IRP Phase I investigation was conducted by ES in 1981 to identify the potential for environmental contamination from past waste use and disposal at inactive and active facilities at Eglin AFB. The old Eglin FTA was identified as a potential source for environmental contamination in the investigation. However, the site was not ranked as a high priority for further evaluation (ES, 1981).

Figure 2.3

HYDROGEOLOGIC CROSS-SECTION A-A'
EGLIN MAIN BASE OLD FTA (FT-28)
EGLIN AFB, FLORIDA



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2.5.2 IRP Phase II Stage 2 Investigation

Even though the site was not ranked as a high priority in the Phase I investigation, the site was included in the IRP Phase II, Stage 2 investigation at the request of the Air Force Systems Command (ES, 1988). The investigation included drilling six soil borings (EAFB1-1 through EAFB1-6), converting three of the borings to monitoring wells (EAFB1-1 through EAFB1-3) and collecting groundwater samples from the wells. Each of the borings was approximately 50 feet in depth. The monitoring wells were installed around the periphery of the site as shown in Figure 2.2. Each of the wells was approximately 50 feet deep and installed in the water table aquifer. Static groundwater level measurements indicated the surficial groundwater flow direction was generally south/southeast toward the intersection of the North-South and East-West runways.

Boring EAFB1-6 was installed at the discharge point of residual fluids to the depression east of the training area. Boring EAFB1-1 was installed approximately 300 feet northeast of the fire training area. Borings EAFB1-2 through EAFB1-5 were advanced either along the perimeter of the site or within the clay surface. Soil samples were collected during drilling of each boring for visual inspection of petroleum contamination. Four of the six boring samples (EAFB1-3, EAFB1-4, EAFB1-5, and EAFB1-6) displayed stained soil and/or exhibited strong fuel odors within the upper 9 feet of the soil column. Samples from two of the six borings (EAFB1-4 and EAFB1-5) also exhibited strong fuel odors near the water table. Chemical analyses were not performed on soil samples during this field effort.

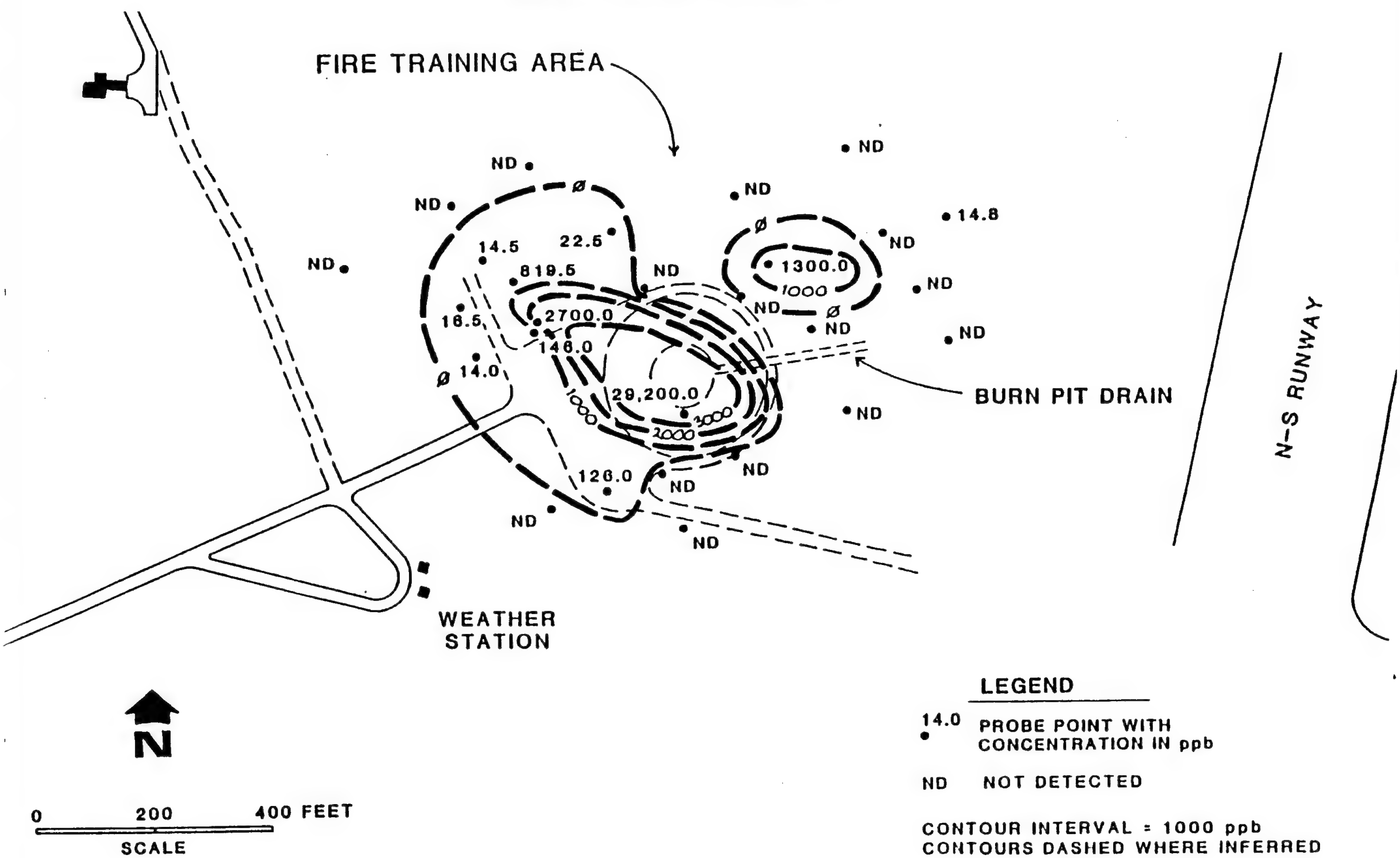
2.5.3 IRP Phase II Stage 3 Investigation

The IRP Phase II, Stage 3 field effort began in March 1988 and was designed to obtain additional data to further characterize the site. A soil gas survey was conducted to aid in soil boring and well sitings. This information was used to advance nine soil borings (1SB1 through 1SB9) to the soil-water interface and install six monitoring wells (1MW1, 1MW2, 1MW3, 1MW4, 1MW5, and 1MW6). Monitoring wells 1MW1 and 1MW3 were installed as four inch diameter deep wells (advanced to 100 feet bls). In addition to the sampling of the new monitoring wells, groundwater samples also were collected from the three previously-installed monitoring wells. The locations of the borings and monitoring wells installed during this investigation are presented in Figure 2.2.

The soil gas survey identified the presence of benzene, toluene, and trichloroethene (TCE). Chlorobenzene and xylenes were also detected. Benzene concentrations ranged from non-detect to 29.2 parts per million, volume per volume (ppmv); toluene concentrations ranged from non-detect to 5.8 ppmv; and TCE concentrations ranged from non-detect to 2.9 ppmv. The distributions of benzene and toluene were very similar with the highest concentrations found beneath the primary burn pit and near the topographic low northwest of the burn pit where rainwater runoff accumulates near 1SB7. The distribution of benzene in the soil gas is presented in Figure 2.4.

Figure 2.4

ISOCONCENTRATIONS OF BENZENE IN SOIL GAS
EGLIN MAIN BASE OLD FTA (FT-28)
EGLIN AFB, FLORIDA



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Review of the results shows that TCE was detected at two locations northwest of the main burn pit. TCE was not detected in soil gas in the area of the main burn pit. The detections were located in the vicinity of soil borings 1SB7, SB9, and SB10. TCE was not detected in soil samples from these borings.

Total petroleum hydrocarbons (TPH) concentrations were detected in samples collected from 7 of 10 soil borings at concentrations ranging from 110 milligrams per kilogram (mg/kg) to 11,000 mg/kg. The highest concentration was from the boring advanced in the center of the burn pit (1SB10). Three samples were collected from this boring up to a depth of 14 feet bls. The concentrations of TPH were comparable for all three samples regardless of depth. A soil boring advanced near the location of 1SB10 during the IRP Phase II, Stage 2 investigation (EAFB1-4) was not sampled but fuel odor was noted throughout the boring depth to the water table.

TPH concentrations were detected in the shallow samples only (less than 9 feet bls) in five of the other six borings (1SB1, 1SB2, 1SB3, 1SB4, and 1SB9) from which samples contained TPH. Samples collected at the water table for these samples were non-detect for TPH. Soil boring 1SB6, located west of the training area, showed an increase in TPH concentration with depth ranging from 520 mg/kg at 5 feet bls to 2200 mg/kg at the water table.

Total BTEX concentrations were detected from five borings at depths less than 20 feet bls ranging from approximately 10.5 mg/kg (1SB6) to 41,000 mg/kg (1SB4). Boring 1SB2, located southeast or the burn pit and within the clay area, was the only boring for which BTEX was detected at the water table. The BTEX concentration detected was approximately 75 mg/kg. With the exception of a BTEX concentration of approximately 250 mg/kg at a sampling depth of 16.5 feet bls from 1SB7, all soil samples from soil borings 1SB5, 1SB7, and 1SB8 were free of detectable petroleum hydrocarbon contamination.

2.5.4 Pilot-Scale Bioventing System Installation and Testing

In March 1994, a pilot-scale bioventing system was installed at the site to evaluate the effectiveness of this technology to reduce hydrocarbon concentrations in the vadose zone soils. During installation of the pilot test bioventing system, significant evidence of soil contamination (strong petroleum odor, staining, and elevated photoionization detector [PID] and total hydrocarbon readings) was observed at the boreholes for the VW and MPs. The inferred extent of soil and soil gas contamination based on previous investigation results and the bioventing pilot test soil and soil gas analyses is depicted in Figure 2.2. Details on the pilot test results are presented in Section 3.

2.5.5 RCRA Facility Investigation

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was performed by O'Brien and Gere in 1995. The RFI field effort began in March 1994 and was designed to define the extent of site contamination (O'Brien & Gere, 1995). A second soil gas survey was conducted, surface and subsurface soils were collected, and

six additional monitoring wells were installed. The BTEX, TPH, phenanthrene, and 2-methylnapthalene results from this investigation are provided in Table 2.1.

Six surface soil samples (SS01 through SS06) were collected within the clay area and around the perimeter of the training area (Figure 2.2). No volatile organic compounds (VOCs) or fuel-related semi-volatile organic compounds (SVOCs) were detected in any of the samples.

Fifteen soil borings (SB01 through SB15) were advanced based on the results of the soil gas survey (Figure 2.2). The highest concentrations of BTEX were detected in soil samples from SB06 and SB12. In these borings, petroleum related compounds including benzene, ethylbenzene, toluene, and xylenes were detected throughout the soil column with the higher concentrations near the water table. The maximum BTEX concentration was detected at the water table from SB12, located south of the former AST area, at a concentration of approximately 433 mg/kg. Napthalene and other components of fuel oil were detected at depth from soil boring samples near the former AST area. However, no VOCs or fuel-related SVOCs were detected above screening levels in any of the samples.

An additional soil boring (SB17) was advanced in April 1996 on the west side of the burn pit within an area of observed black-stained soil. Total BTEX compounds detected in shallow soil (2 to 4 feet bls) were approximately 13 mg/kg {benzene (0.25 mg/kg), ethylbenzene (6.6 mg/kg), and xylenes (6.1 mg/kg)}. The SVOC 2-methylnapthalene was detected at 22 mg/kg. Benzene was detected at a concentration of 0.0007 mg/kg in the soil sample collected from the water table. Toluene, ethylbenzene, xylenes, and the SVOC 2-methylnaphthalene were not detected at depth.

Ten hand auger borings were also completed to depths of up to 5 feet bls in May 1996 to determine the extent of the black stained soils surrounding the primary burn pit. The extent of heavily stained soils was determined through visual inspection and headspace measurements of hand auger samples using a flame ionization detector (FID) (O'brien and Gere, 1996a). The extent of heavily stained soils is presented on Figure 2.2.

2.5.6 RCRA Corrective Measures Study

The RFI and subsequent risk assessment concluded that hypothetical future risks to adult and child residents are primarily associated with ingestion of contaminated groundwater, inhalation of VOCs in groundwater through showering, and dermal contact with groundwater through showering (O'Brien & Gere, 1995). The RFI indicated contaminants currently present in surface and subsurface soil are a continued source of groundwater contamination.

A RCRA Corrective Measures Study (CMS) was performed by O'Brien and Gere in 1996. The CMS was based on the results of previous investigations and the 1995 RFI. The selected remediation alternative included modification of the existing bioventing system to continue *in situ* treatment of soil near the burn pit and extension to the AST area.

TABLE 2.1
BTEX, 2-Methylnaphthalene, Phenanthrene, and TPH Concentrations Detected in Soil
Old Eglin FTA - (Site FT-28)
Eglin AFB, Florida

Sampling Location	Depth (feet, bgs)	TPH (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	2-Methylnaphthalene (mg/kg)	Phenanthrene (mg/kg)
SB01	32	NA	0.0028U	0.0028U	0.0028U	0.0028U	0.18U	0.18U
SB01	36	NA	0.0029U	**0.001J**	0.0029U	0.0029U	0.18U	0.18U
SB01	42	NA	0.0029U	**0.0014J**	0.0029U	0.0029U	0.19U	0.19U
SB02	28	NA	0.0026U	0.0026U	0.0026U	0.0026U	0.17U	0.17U
SB02	34	NA	**0.0026J**	0.0028U	**0.0013J**	**0.0006J**	0.18U	0.18U
SB02	42	NA	0.0029U	0.0029U	0.0029U	0.0029U	0.19U	0.19U
SB03	28	NA	0.013U	**0.0171**	**0.084**	**0.096**	**10.2**	1.71U
SB03	34	NA	0.33U	**0.3078J**	**1.89**	**11.6**	**12.3H**	1.69U
SB03	50	NA	0.36U	**0.2872J**	**0.4113**	**2.1**	**8.8**	0.36U
SB04	4	NA	0.0026U	0.0026U	0.0026U	0.0026U	1.7U	1.7U
SB04	32	NA	0.003U	0.003U	0.003U	0.003U	0.19U	0.19U
SB04	38	NA	0.0029U	0.0029U	0.0029U	0.0029U	0.19U	0.19U
SB05	4	NA	1.3U	1.3U	**2.4**	**11**	**1.99**	**0.5584**
SB05	30	NA	0.0025U	0.0025U	0.0025U	0.0025U	0.16U	0.16U
SB05	42	NA	**0.0056**	0.0029U	**0.0039**	**0.0301**	0.18U	0.18U
SB06	20	NA	0.013U	0.013U	**0.17**	**0.41**	**11**	0.33U
SB06	38	NA	**0.0012J**	**0.0008J**	**0.0014J**	**0.0031**	0.18U	0.18U
SB06	44	NA	**0.0218**	0.0029U	**0.023**	**0.1003**	0.19U	0.19U
SB07	36	NA	0.33U	0.33U	**1.08**	**7**	**0.53**	0.17U
SB07	38	NA	0.38U	0.36U	**6.51**	**41.8**	**7.39**	0.37U
SB07	46	NA	0.03U	0.03U	**0.0388J**	**0.219**	0.19U	0.19U
SB08	32	NA	0.0028U	0.0028U	0.0028U	0.0028U	0.18U	0.18U
SB08	36	NA	0.003U	**0.0011J**	0.003U	0.003U	0.19U	0.19U
SB08	42	NA	0.0029U	0.0029U	0.0029U	0.0029U	0.19U	0.19U
SB09	22	NA	0.0026U	0.0026U	0.0026U	0.0026U	0.16U	0.16U
SB09	32	NA	0.0028U	0.0028U	0.0028U	0.0028U	0.18U	0.18U
SB09	40	NA	NA	NA	NA	NA	0.18U	0.18U
SB10	32	NA	0.0025U	0.0025U	0.0025U	0.0025U	0.16U	0.16U
SB10	34	NA	0.0027U	0.0027U	0.0027U	0.0027U	0.17U	0.17U
SB10	42	NA	0.0029U	0.0029U	0.0029U	0.0029U	0.18U	0.18U
SB11	32	NA	0.0029U	0.0029U	0.0029U	0.0029U	0.19U	0.19U
SB11	36	NA	0.003U	**0.0018J**	0.003U	0.003U	0.19U	0.19U
SB11	42	NA	0.003U	0.003U	0.003U	0.003U	0.19U	0.19U
SB12	36	NA	0.35U	**0.6335**	**1.52**	**11.4**	**1.43**	0.18U
SB12	44	NA	**11**	**69.6**	**51.2**	**302**	**78.3**	0.19U
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SB13	32	NA	0.0027U	**0.0011J**	0.0027U	0.0027U	0.17U	0.17U
SB13	36	NA	0.003U	0.003U	0.003U	0.003U	0.19U	0.19U
SB13	42	NA	0.0027U	0.0027U	0.0027U	0.0027U	0.17U	0.17U
SB14	28	53.5U	0.0026U	0.0026U	0.0026U	0.0026U	0.169U	0.169U

TABLE 2.1
BTEX, 2-Methylnaphthalene, Phenanthrene, and TPH Concentrations Detected in Soil
Old Eglin FTA - (Site FT-28)
Eglin AFB, Florida

Sampling Location	Depth (feet, bgs)	TPH (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	2-Methylnaphthalene (mg/kg)	Phenanthrene (mg/kg)
SB14	32	47.4U	0.0026U	0.0026U	0.0026U	**0.0012J**	0.169U	0.169U
SB14	34	**102**	0.0026U	0.0026U	0.0026U	**0.0017J**	0.167U	0.167U
SB15	24	44.4U	0.0027U	0.0027U	0.0027U	0.0027U	0.173U	0.173U
SB15	32	42.0U	0.0027U	0.0027U	0.0027U	0.0027U	0.171U	0.171U
SB15	34	37.6U	0.0028U	0.0028U	0.0028U	0.0028U	0.179U	0.179U
SB17	4	NA	**0.25**	ND	**6.6**	**6.1**	**22**	**1.8**
SB17	42	NA	**0.0007J**	ND	0.0023U	0.0023U	0.18U	0.18U
FT28-04	6	**13861**	0.0134U	0.0134U	**5.96**	**9.05**	**4.61**	**0.3648**
FT28-04	34	NA	**0.004**	**0.0101**	**0.0061**	**0.0114**	0.184U	0.184U
FT28-05	6	**77.4**	0.0026U	0.0026U	0.0026U	0.0026U	NA	NA
FT28-05	34	**46.1**	0.0027U	0.0027U	0.0027U	0.0027U	NA	NA
FT28-06	24	NA	0.0027U	0.0027U	0.0027U	0.0027U	0.171U	0.171U
FT28-06	30	NA	0.0027U	0.0027U	0.0027U	0.0027U	0.17U	0.17U
FT28-06	32	NA	0.0028U	0.0028U	0.0028U	0.0028U	0.18U	0.18U

Notes:
bgs - below ground surface.
mg/kg - milligrams per kilogram.
Bold print indicates compound detections.
BTEX compounds were analyzed using Method SW8260
H - Biased High J - Estimated value NA - Not Analyzed/Not Available
U - Not detected above laboratory reporting limits.
ND - Not Detected. Laboratory reporting limit not available.
Source: O' Brien & Gere, Old Eglin FTA Site FT-28 RFI, 1995

2.5.7 Investigation Summary

Field observations, field screening results, and soil and soil gas analytical results indicate that the soils beneath the burn pit are contaminated throughout the soil column to the water table. The highest concentrations of contaminants within and surrounding the burn pit are located in the shallow soil horizon (less than 10 feet bls). These detections correlate well with an area of shallow black stained soils that has been identified within and surrounding the primary burn pit. Fluctuating groundwater table elevations may also have caused a smearing of petroleum hydrocarbons in soils near the water table in areas beneath and surrounding the primary burn pit. Results from surface soil sampling conducted during the 1995 RFI indicate that volatile organic compounds are not present at detectable levels in the surface soils across the site. This suggests that the shallow concentration of VOCs in soil ranges from 2 to 10 feet bls.

A soil gas survey conducted in 1988 identified the presence of benzene, toluene, and TCE in the soil gas beneath the burn pit toward topographic low to the northwest where rainwater runoff accumulates. The most recent soil sample results collected during the RFI in 1995 indicated that benzene, ethylbenzene, toluene and xylenes were present at maximum concentrations of 11 mg/kg, 51.2 mg/kg, 69.6 mg/kg, and 302 mg/kg, respectively. TCE was not detected. Soil samples collected from within the radius of influence of the existing VW after 12 months of bioventing indicated remediation of BTEX to near non detectable concentrations.

The remaining contaminated areas are outside the radius of influence of the existing pilot-scale bioventing system. The proposed upgrade to the bioventing pilot system is designed to provide the necessary oxygen and stimulate *in situ* biodegradation throughout the remaining contaminated soil.

3. BIOVENTING PILOT TEST RESULTS

A bioventing pilot test was performed by Parsons ES at the old Eglin FTA from July 1994 through July 1995. The objectives of the initial bioventing pilot test were to:

- Assess the potential for supplying oxygen throughout the contaminated soil interval;
- To determine the rate at which indigenous microorganisms will degrade fuel when stimulated by oxygen-rich soil gas at this site; and
- To evaluate the potential for sustaining these rates of biodegradation until fuel contamination is remediated below regulatory approved standards.

Because bioventing has been demonstrated to be a feasible technology for this site, the pilot test data were used to design a full-scale remediation system (Section 4) to remediate the soils at the site, minimize potential releases to groundwater/surface water, and lower contaminant concentrations throughout the site to below regulatory standards.

Based on the results from the soil gas survey conducted as part of the IRP Phase II Stage III Investigation, a VW and three MPs were installed along the southern edge of the primary burn pit. The VW was installed to facilitate the injection of ambient air into the vadose zone. The MPs were installed to monitor the *in situ* biodegradation rates, as well as to determine the radius of oxygen influence of the VW. The locations of the VW, MPs, and blower are presented in Figure 2.1. Figure 2.2 depicts the hydrogeologic cross section at the old Eglin FTA and provides a profile of the bioventing system.

3.1 SYSTEM CONSTRUCTION

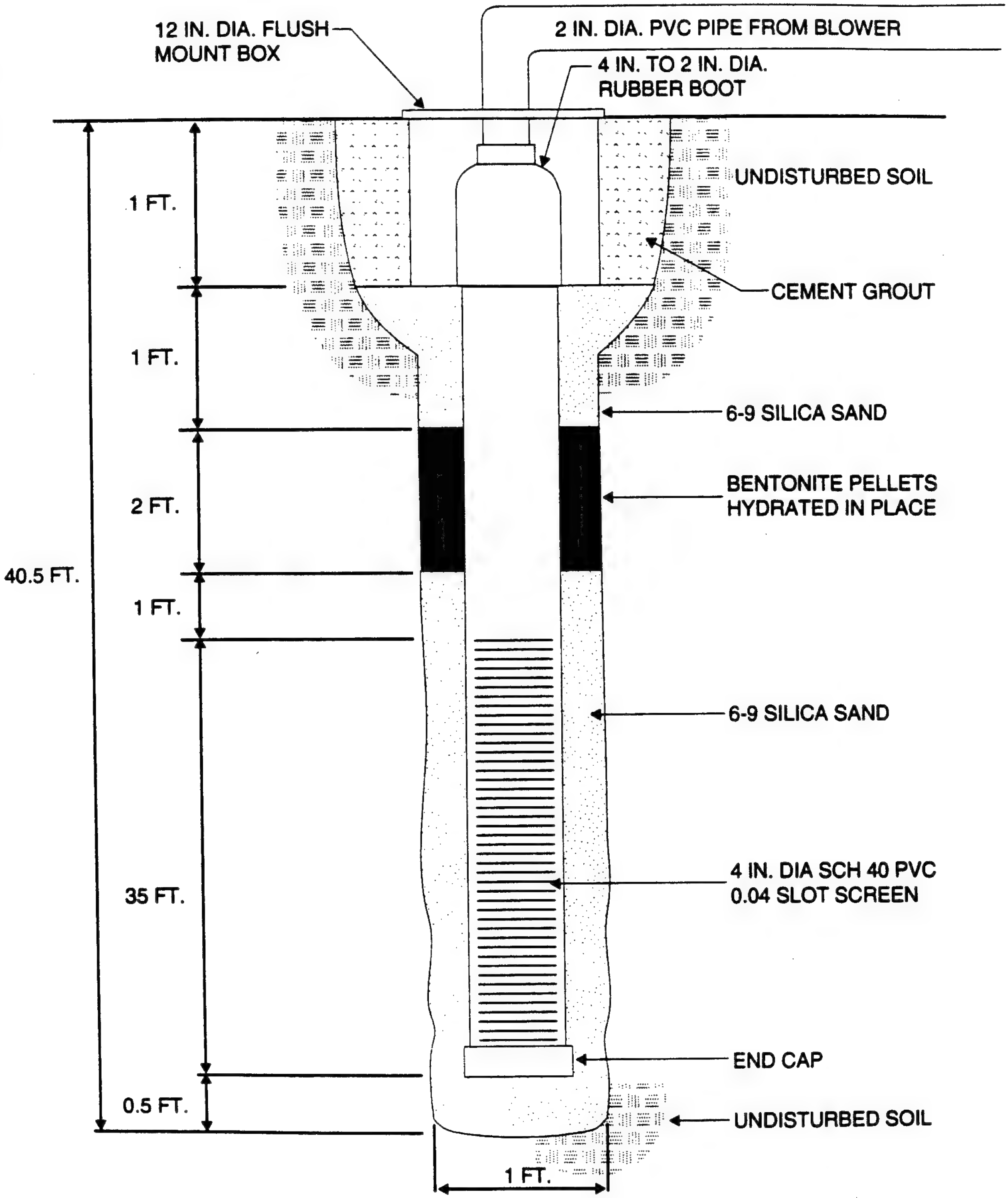
3.1.1 VW Construction

The VW was installed on March 1, 1994, and was constructed of 4-inch diameter Schedule 40 PVC with a slot size of 0.04 inches. The total depth of the VW was 40 feet bls, with a screened interval from 5 to 40 feet bls. A construction detail of the VW is presented on Figure 3.1.

3.1.2 Soil Vapor Monitoring Points

Three soil MPs were installed at 10, 20 and 40 feet radially away from the air injection VW. Each MP was constructed to provide multiple depth soil gas monitoring with three discrete sample points at 4.5 to 5 feet, 25.5 to 26 feet, and 38.5 to 39 feet bls. Each discrete point was constructed of a 6-inch long piece of 1/2-inch inner diameter (ID) Schedule 40 PVC well screen with 0.02 slot size. The riser of each discrete point was constructed of 1/2-inch ID Schedule 80 PVC, which extended to approximately six inches bls.

INJECTION VENT WELL CONSTRUCTION DETAIL
EGLIN MAIN BASE OLD FTA - (SITE FT-28)
EGLIN AFB, FLORIDA



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PARSONS ENGINEERING SCIENCE, INC.

Additionally, Type K thermocouples with mini connectors were installed at the 39 feet and 5 feet bls discrete monitoring points in the MP closest to the VW (MPA). These thermocouples were installed to measure the temperature profile at the site. The top of each MP was completed with a 12-inch-diameter flush mounted protective well cover set in a concrete base. Figure 3.2 shows the construction of the soil MP.

3.1.3 Blower Unit Installation

A one-horsepower Gast® regenerative blower unit was installed at the site for the initial and extended pilot tests. The blower was installed in a weather-resistant enclosure and electrically wired for permanent 240-volt, single-phase, 30-amp service. Air from the blower is injected into the VW via a 2-inch-diameter PVC line connected to the blower's exhaust port. At the time of installation, the blower unit was injecting air at approximately 92 cubic feet per minute (cfm).

3.2 PILOT TEST SOIL AND SOIL GAS SAMPLING RESULTS

3.2.1 Soil and Soil Gas Sampling Results

Hydrocarbon contamination at the site appears to extend from the ground surface to the groundwater table. However, at depths between 15 and 30 feet bls evidence of contamination was minimal. Contaminated soils collected by split spoons during the VW and MP installations were identified based on visual appearance, odor and PID screening. Varying degrees of hydrocarbon staining were encountered throughout the vertical profile in the unsaturated soil zone, and light to strong hydrocarbon odors were noticed in nearly all the split spoon samples. PID readings of greater than 20,000 ppmv were measured in a number of soil samples.

Soil gas samples were collected, prior to performing the air permeability test, in laboratory provided, evacuated Summa® canisters. Soil gas samples were collected from the VW, the 4.5 to 5 feet bls discrete monitoring point at MPA, and from the 38.5 to 39 feet bls discrete monitoring point in MPC. All soil gas samples were collected following procedures in the Protocol Document (Hinchee et al, 1992; Downey and Hall, 1994).

Each soil sample was analyzed for TRPH; BTEX; iron; alkalinity; total Kjeldahl nitrogen (TKN); pH; phosphates; percent moisture; and grain size distribution. Soil gas samples were placed in a shipping box (without ice), and shipped via Federal Express® to Air Toxics, Inc., in Folsom, CA for TVH and BTEX analysis. The analytical results for these soil and soil gas samples are presented in Table 3.1.

3.3 PILOT TEST RESULTS

3.3.1 Initial Test

3.3.1.1 Initial Soil Gas Chemistry

Prior to initiating any air injection, soil gas in the VW and all MPs was sampled for TVH, oxygen, and carbon dioxide. Oxygen depletion was measured around the burn pit. The results of the initial monitoring is presented in Table 3.2.

Figure 3.2

VAPOR MONITORING POINT CONSTRUCTION DETAIL
EGLIN MAIN BASE OLD FTA - (SITE FT-28)
EGLIN AFB, FLORIDA

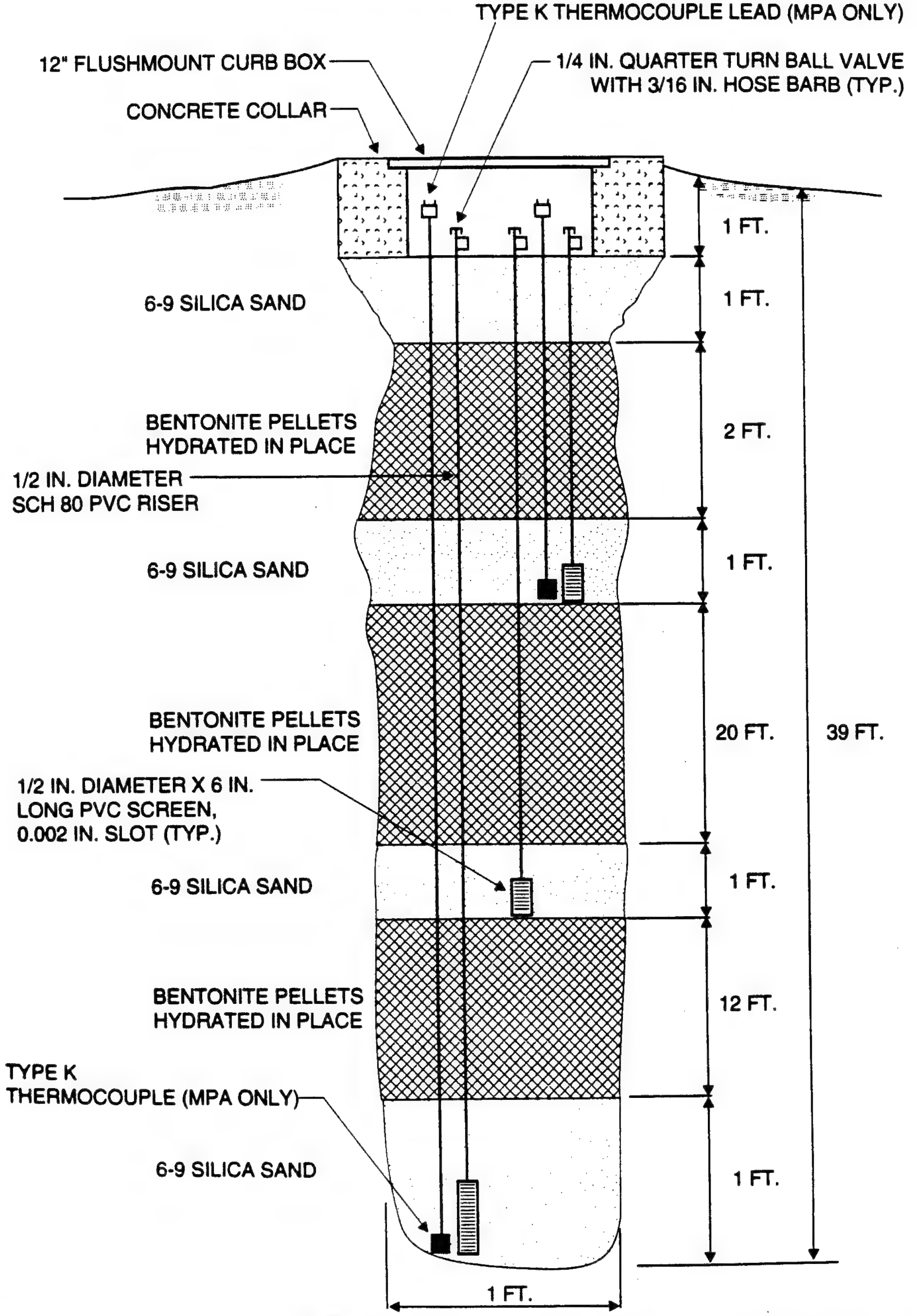

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TABLE 3.1
INITIAL AND 1-YEAR SOIL AND SOIL GAS ANALYTICAL RESULTS
EGLIN MAIN BASE OLD FTA (FT-28)
EGLIN AFB, FLORIDA

Analyte (Units) [a]	Sample Locations-Depth (feet below ground surface)					
	EG2-VW		EG2-MPA-4.5-5		EG2-MPC-38.5-39	
Soil Gas Hydrocarbons	Initial [b]	1-Year [c]	Initial	1-Year	Initial	1-Year [d]
TVH (ppmv)	11,000	1.6	11,000	79	26,000	10
Benzene (ppmv)	94	0.002	93	0.13	250	0.034
Toluene (ppmv)	52	0.004	24	0.037	460	0.012
Ethylbenzene (ppmv)	20	<0.002	20	0.016	47	0.025
Xylenes (ppmv)	76	<0.002	64	0.094	220	0.09
	EG2-VW-3-5		EG2-MPA-33-39 [f]		EG2-MPB-2-4	
Soil Hydrocarbons	Initial [b]	1-Year [e]	Initial	1-Year	Initial	1-Year
TRPH (mg/kg)	2,210	4,500	3,370	70.8	6,610	5,290
Benzene (mg/kg)	10	0.057	0.15	< 0.050	< 2.7	0.14
Toluene (mg/kg)	21	0.11	0.19	0.050	< 2.7	0.26
Ethylbenzene (mg/kg)	24	1.4	0.4	< 0.050	9.9	1.80
Xylenes (mg/kg)	72	< 0.13	2.5	< 0.130	22	2.60
Moisture (%)	6.0	14.0	7.0	18.4	7.6	16.3

[a] TVH=total volatile hydrocarbons: ppmv = parts per million, volume per volume;
TRPH = total recoverable petroleum hydrocarbons; mg/kg = milligrams per kilogram.
[b] Initial soil gas samples collected on March 16, 1994.
[c] Final soil gas samples collected on July 24, 1995. Blower system was shut down approximately 30 days prior to soil gas sampling to allow soil gas to come to equilibrium with soils.
[d] Initial soil samples collected on March 3, 1994.
[e] Final soil samples collected on July 28,1995 for VW and MPB, and on October 20, 1995 for MPA.
[f] Initial soil samples collected at 37-39 feet below ground surface (bgs). 1-Year soil sample collected at 33-34 feet bgs.

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TABLE 3.2
INITIAL SOIL GAS CHEMISTRY
OLD EGLIN FTA (FT-28)
EGLIN AFB, FLORIDA

MP	Screen Interval (ft, bls)	O2 (%)	CO2 (%)	TVH (ppm)
VW	5 - 40	0.0	10.5	20,000+
MPA	4.5 - 5.0	0.0	10.25	20,000+
MPA	25.5 - 26.0	0.0	10.25	20,000+
MPA	38.5 - 39.0	NM	NM	NM
MPB	4.5 - 5.0	0.0	10.25	20,000+
MPB	25.5 - 26.0	0.0	10.25	20,000+
MPB	38.5 - 39.0	0.0	10.5	20,000+
MPC	4.5 - 5.0	0.0	10.75	20,000+
MPC	25.5 - 26.0	0.0	10.5	20,000+
MPC	38.5 - 39.0	0.0	11	20,000+

NM - Not Measured (unable to draw sample because the sample point was flooded.)

As shown in Table 3.2, the VW and all MPs had completely depleted oxygen levels (0.0 percent), high carbon dioxide readings (greater than 10 percent), and TVH readings exceeding 20,000 ppmv. These readings suggest that indigenous microorganisms have completely depleted the naturally available oxygen supply, indicating significant biological activity. In contrast, the background monitoring point (EAFB1-1) indicated near atmospheric conditions in soil gas (i.e. greater than 20 percent oxygen and less than 0.5 percent carbon dioxide) to a depth of at least 35 feet bls.

3.3.1.2 Air Permeability

An air permeability test was conducted according to the Protocol Document procedures on 23 March 1994 (Hinchee et al, 1992; Downey and Hall, 1994). Air was injected into the VW for two and one-half hours at a rate of approximately 92 cfm and an average pressure of 4 inches of water. Steady-state pressure levels were achieved at all MPs in approximately 150 minutes. Table 3.3 provides the maximum steady-state pressures at each discrete monitoring point.

Due to the gradual response and relatively lengthy time to achieve steady-state conditions, the dynamic method of determining soil permeability was selected (Hinchee et al., 1992). Using the HyperVentilate® model, an air permeability value ranging from 77 to 305 darcys was calculated for this site. The air permeability, calculated using the steady-state method, was 70.4 darcys. The radius of pressure influence is estimated to exceed 60 feet.

3.3.1.3 Oxygen Influence

The depth and radius of oxygen influence in the subsurface resulting from air injection into the central VW is the primary design parameter for bioventing systems. Optimization of full-scale and multiple VW systems requires pilot testing to determine the volume of soil that can be oxygenated at a given flow rate and screen configuration.

Based on the oxygen increase and the pressure response observed at all of the monitoring points during the system start-up period, it was estimated that the long-term radius of oxygen influence at the old Eglin FTA would exceed 40 feet when air was injected at a rate of approximately 30 cfm.

3.3.1.4 *In-Situ* Respiration Rates

Initial *in-situ* respiration tests were performed at the following monitoring points and depths: MPA (4.5 to 5 feet bls), MPB (25.5 to 26 feet bls), and MPC (38.5 to 39 feet bls). These points were chosen based on their low oxygen readings (0.0 percent), high carbon dioxide readings (greater than 10 percent), and high TVH readings (greater than 20,000 ppmv. Oxygen utilization rates observed at the site were very consistent and ranged from 0.06 to 0.24 percent per hour.

At old Eglin FTA, an estimated 860 milligrams (mg) of fuel per kilogram of soil can be degraded each year. This value is the average of the fuel consumption rates calculated for every point at which a respiration test was conducted. The interval-

TABLE 3.3
MAXIMUM PRESSURE RESPONSE DURING
AIR PERMEABILITY TEST
OLD EGLIN FTA (FT-28)
EGLIN AFB, FLORIDA

	Distance from injection well (VW)								
	10' (MPA)			20' (MPB)			40' (MPC)		
Depth (feet)	4.5	25.5	38.5	4.5	25.5	38.5	4.5	25.5	38.5
Time (minutes)	150	150	-	125	125	-	150	150	150
Max Pressure (inches H_2O)	2.15	2.6	-	1.8	1.77	-	1.4	1.5	1.5

Note: Water table may have risen above the screen at the deep monitoring points at MPA and MPB.
Readings could not be obtained at these points.

specific fuel consumption rates were calculated using observed oxygen utilization rates, estimated air-filled porosities, and a conservative ratio of 3.5 mg of oxygen consumed for every 1 mg of fuel biodegraded. The air-filled porosity calculated for each sampling point ranged from 0.09 to 0.17 liters of air per kilogram of soil.

3.3.1.5 Potential Air Emissions

The long-term potential for air emissions from full-scale bioventing operations at the site were considered to be low because of the age and type of the site contaminants (greater than 5 years, and primarily JP4 jet fuel). Additionally, health and safety monitoring conducted during the permeability test using a PID sensitive to 1 ppmv did not detect any hydrocarbons above background levels in the breathing zone or at the ground surface. Because the potential for air emissions is highest during the initial air injection period, and no emissions were detected, the long-term emission potential is considered low. Current BTEX levels at the site are low, therefore, future BTEX emissions are expected to be negligible. Finally, the site is isolated at Eglin Main Base, and is in excess of several hundred feet from any regularly occupied building.

3.3.2 3-Month and 1-Year Bioventing Results

3.3.2.1 System Operation

Upon initial startup of the air injection system at 92 cfm, the oxygen influence was monitored at MPC, 40 feet from the VW. The initial oxygen level at this point was 0 percent. After 17 hours at the 92 cfm injection rate, the oxygen content at the deepest injection point of MPC had risen to approximately 20 percent. Since sufficient oxygen was being supplied within this 40-foot radius of influence, the air injection flow rate of 92 cfm was maintained throughout the remainder of the 1-year bioventing pilot test study. Weekly system checks were conducted to ensure consistent system operation and performance.

3.3.2.2 *In Situ* Biodegradation Rates

Initial, 3-month and 1-year in situ respiration tests and initial and 1-year soil sampling events were completed as part of the bioventing pilot test. Table 3.4 shows the estimated fuel biodegradation rates in milligrams of TRPH per kilogram of soil per year (mg/kg/yr) at MPA, MPB, and MPC locations, based on the initial, 3-month and 1-year respiration tests.

Initial biodegradation rates ranged from 220 to 1,400 mg/kg/year. After 3 months of bioventing, biodegradation rates ranged from 28 to 3,800 mg/kg/year. At MPA-4.5-5 and MPB-25.5-26, oxygen utilization rates had decreased since system start-up. This is explained by the fact that the initial test (as well as the 1-year test) was a point respiration test (using 1-cfm pumps for air injection) and the 3-month test was an area respiration test (using the blower system for air injection). Because the area testing method delivers a much greater volume of oxygen to the soils than the point testing method, oxygen diffusion is greater and apparent oxygen utilization rates are often lower. At the end of the 1-year testing period, rates ranged from 270 to 6,300 mg/kg/year. During each

TABLE 3.4
RESPIRATION AND DEGRADATION RATES
OLD EGLIN FTA (SITE FT-28)
EGLIN AFB, FLORIDA

Location-Depth (feet below ground surface)	Initial (March 1994)[e]			3-Month (September 1994)[b]			12-Month (July 1995)[f]		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year)[a]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA (4.5 - 5')	0.0042	1,400	14.8	0.0018	620	NS	0.0061	1,100	28.4
MPA (25.5 - 26')	NS[c]	NC[d]	NS	0.00011	28	NS	0.0090	270	NS
MPA (38.5 - 39')	NS	NC	21.3	NS	NS	NS	NS	NC	21.8
MPB (4.5 - 5')	NS	NC	NS	0.0027	930	NS	0.031	5,600	NS
MPB (25.5 - 26')	0.0035	900	NS	0.00051	130	NS	0.0049	150	NS
MPC (4.5 - 5')	NS	NC	NS	0.011	3,800	NS	0.035	6,300	NS
MPC (25.5 - 26')	NS	NC	NS	0.0015	380	NS	0.0094	280	NS
MPC (38.5 - 39')	0.0013	220	NS	NS	NS	NS	NS	NC	NS

[a] Milligrams of hydrocarbons per kilogram of soil per year.
[b] Degradation calculation assumes moisture content of the soil is average of initial and final moistures.
[c] NS = Not sampled. [d] NC = Not calculated.
[e] Due to a delay in power installation, the extended test did not begin until July 6, 1994.
[f] Assumes moisture content of 5 foot depths equal to the average soil moistures determined at VW-3-5 and MPB-2-4 for July 28, 1995 soil samples. Soil moisture at 26 foot depths assumed to be equal to moisture content at MPA-33-34 collected on October 20, 1995.

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respiration test, biodegradation rates observed in shallow soil zones were substantially higher than those observed in deeper soils, indicating that higher concentrations of soil bacteria and biodegradable fuel hydrocarbons may be present in shallow soils (between the ground surface and approximately 10 feet bgs). After one year of treatment, biodegradation rates in shallow soils ranged from 1,100 to 6,300 mg/kg/yr and rates in deeper soils ranged from 150 to 280 mg/kg/yr, indicating that soils would benefit from continued bioventing treatment.

3.3.2.3 1-Year Soil and Soil Gas Sampling Results

Upon completion of the 1-year study, final soil and soil gas samples were collected from the initial sample locations. Table 3.1 shows the initial , and 1-year soil and soil gas laboratory sampling results from the VW, MPA, and MPC locations. As shown on Table 3.1, BTEX and TVH concentrations in soil gas and BTEX concentrations in soil were significantly reduced. However, TRPH concentrations at one of the three sampling locations increased. These increases in concentration may be attributable to spatial variations in TPH concentrations in the soil.

3.3.2.4 Recommendation for Full-Scale Bioventing

Based on the overall positive results of the 1-year bioventing pilot tests, AFCEE has provided funding for the design and installation of an expanded bioventing system that will remediate remaining contaminated soils at the old Eglin Field FTA. AFCEE has retained Parsons ES to continue bioventing services at Eglin AFB and to complete the design and installation of an expanded bioventing system. Based on the initial pilot test results, available analytical data, and recently completed soil sampling, Parsons ES has prepared a conceptual full-scale upgrade design that will employ the existing VW, existing monitoring well FT28-03, and up to four additional VWs. Three additional MPs also will be installed to ensure oxygen is being delivered to contaminated soils. During installation of the boreholes for the additional MPs and VWs, field observations of contamination will be used to determine the necessity of the VWs proposed. Section 4 provides details on the design, construction, and operation of the expanded system. A design package has been prepared for construction of the system and is included in Appendix A of this ICM work plan.

4. EXPANDED BIOVENTING SYSTEM

The purpose of the expanded bioventing system is to provide oxygen to stimulate aerobic biodegradation of the remaining soil contamination present at the old Eglin FTA. Four additional air injection VWs and existing monitoring well FT28-03 will be used to provide oxygen to the remaining oxygen-depleted, unsaturated and contaminated soils at the site. Three additional MPs will be installed to ensure that oxygen is being delivered to contaminated soils. System design details are provided in Appendix A.

4.1 OBJECTIVES

Following its installation, the primary objectives for the expanded bioventing system will be to:

- Fully aerate the unsaturated subsurface in areas at the site designated for bioventing remediation;
- Reduce hydrocarbon concentrations in soil;
- Eliminate the potential for contamination to migrate and adversely affect groundwater quality at the site by reducing the contaminant source from vadose soils; and
- Provide the most cost-effective remediation alternative for petroleum hydrocarbon contaminants at the site.

4.2 BASIS OF DESIGN

Site investigation data, pilot test data, and experience at other bioventing sites provide the main elements of the basis of design. The expanded bioventing system was designed to provide oxygen to areas of significant soil contamination. Both vadose zone and smear zone contaminated soils have been targeted. The design includes installing four VWs and three MPs.

Pilot test data, such as operating pressure and radius of oxygen influence, were considered during design development. These data were considered in the spacing of VWs and sizing of a full-scale blower system. In addition to the pilot test data from these sites, experience at other sites with similar soil types was considered in design development. Experience at other sites was used only where there were shortcomings in the pilot test data, such as uncertainty in accuracy of the flow rate data.

The significant design parameters and considerations are as follows:

- A radius of oxygen influence of 60 feet was used, resulting in a 110 foot spacing between VWs. However, to effectively treat potentially higher contaminated soils in the area of concern (near the burn pit) VWs have been spaced more closely.
- An air injection pressure of 3 to 5 inches of water was assumed in sizing the full-scale bioventing blower. This is consistent with pressures observed during the extended pilot test.
- An air injection flow rate of 35 cfm per VW (approximately one cfm per foot of screen) was assumed based on the pilot test system performance and experience at other sites with similar geology.

The locations of the three additional MPs were selected to provide information as to the extent of vadose zone and smear zone contamination, evaluate the magnitude of contaminant reduction through soil gas sampling, and provide important oxygen influence data. The proposed MPs will be located near potential "dead zones" and on the periphery of the design radius of oxygen influence (Figure 4.1).

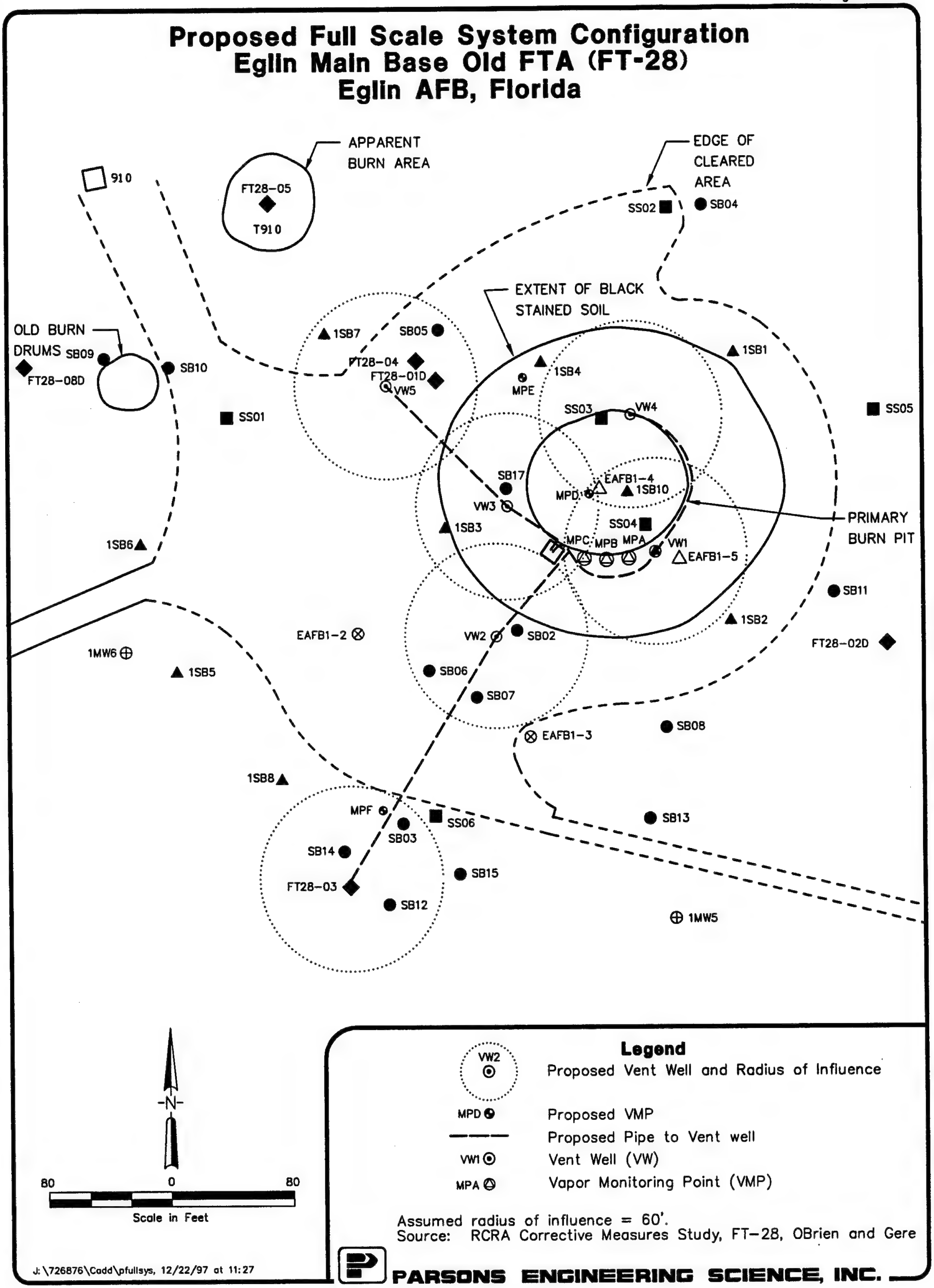
4.3 SYSTEM DESIGN

The proposed upgrade to the existing bioventing system will incorporate the existing VW, existing monitoring well FT28-03, and up to four new VWs. The additional VWs will be installed to ensure proper oxygen influence throughout the area of the soil contamination. The new VWs will be 2 inches in diameter and will be screened with 0.040-inch slot from 5 to 40 feet bls. Figure 4.1 shows the proposed locations of the existing and new VWs and MPs with the estimated radius of influence. The piping from the blower to the new VWs will be installed below ground. Design details are included in the design package provided in Appendix A. A well construction diagram for monitoring well FT28-03 is provided in Appendix B.

The VWs will be manifolded using 1.5-inch-diameter, high density polyetheylene (HDPE) piping as the conduit for the injected air to flow from the blower to the proposed VWs. The piping will be connected to a new 3 HP regenerative blower and will be set inside a new weather-proof enclosure. A separate (manual) flow control valve and flow measurement port will be included in the lines connecting each VW to allow adjustment of the air flow to each VW.

Based on experience at other bioventing sites, a maximum injection rate of 35 cfm at each VW and monitoring well FT28-03 should be sufficient to supply oxygen to the remaining contaminated soils and sustain *in situ* fuel biodegradation. The radius of oxygen influence around each VW was estimated to extend at least 60 feet based on our experience at other sandy sites, the data collected during the initial pilot testing, and radius of oxygen influence calculations using an equation provided in "*Principles and Practices of Bioventing: Volume II: Bioventing Design*" prepared for AFCEE and U.S.

Figure 4.1



Proposed Full Scale System Configuration
Eglin Main Base Old FTA (FT-28)
Eglin AFB, Florida
APPARENT BURN AREA
EDGE OF CLEARED AREA
EXTENT OF BLACK STAINED SOIL
OLD BURN DRUMS
PRIMARY BURN PIT
910
FT28-05
T910
SS02
SB04
1SB7
SB05
SB09
SB10
FT28-08D
FT28-04
FT28-01D
VW5
1SB4
MPE
1SB1
SS05
SS01
SS03
VW4
SB17
EAFB1-4
MPD
1SB10
VW3
SS04
1SB3
1SB6
MPC
MPB
MPA
VW1
EAFB1-5
SB11
1SB2
EAFB1-2
VW2
SB02
FT28-02D
1MW6
1SB5
SB06
SB07
EAFB1-3
SB08
1SB8
MPF
SS06
SB13
SB03
SB14
SB15
FT28-03
SB12
1MW5
-N-
80
0
80
Scale in Feet
Legend
Proposed Vent Well and Radius of Influence
Proposed VMP
Proposed Pipe to Vent well
Vent Well (VW)
Vapor Monitoring Point (VMP)
Assumed radius of influence = 60'.
Source: RCRA Corrective Measures Study, FT-28, OBrien and Gere
J:\726876\Cadd\pfullsys, 12/22/97 at 11:27
PARSONS ENGINEERING SCIENCE, INC.

Environmental Protection Agency (USEPA) (Leeson and Hinchee, 1995). The radius of oxygen influence calculation set is provided in Appendix E. The VW locations were selected to make use of existing MPs and to provide coverage of contaminated soils. With the exception of monitoring well FT28-03, a spacing of approximately 110 feet (not-to-exceed distance) between VWs is planned.

4.4 PROJECT SCHEDULE

Following review and approval of the system upgrade ICM work plan by AFCEE/ERT, Eglin AFB, USEPA Region IV, and the Florida Department of Environmental Protection (FDEP), field work will begin. The project schedule, presented on Figure 4.2, for the upgrade is contingent upon timely approval of this ICM work plan.

4.5 SYSTEM OPERATION AND MONITORING

Following system installation, an Operation and Maintenance (O&M) plan and record system drawings will be prepared.

4.5.1 System Operation

At startup of the full-scale system, it will be necessary to optimize the air injection rate and to ensure proper operation of the blower system. Flow rate optimization is accomplished by gradually increasing the flow rate to each VW until soil gas oxygen concentrations at all MP depth intervals reach a minimum concentration of approximately 10 percent. Oxygen levels in excess of 10 percent at the outer MPs may indicate that the volume of air passing through the soil exceeds the biological oxygen utilization. The blower will be checked to ensure that it is producing the required flow rate and pressure for air injection.

O&M requirements for the proposed bioventing system are minimal. The regenerative blowers are virtually maintenance-free. The only recurring maintenance required is a monthly check of the air filter, which is generally replaced when a pressure difference of 10 to 15 inches of water across the inlet filter is reached. The time period between filter changes is dependent on site conditions, and is typically every 3 to 6 months. The O&M manual will further detail operation requirements.

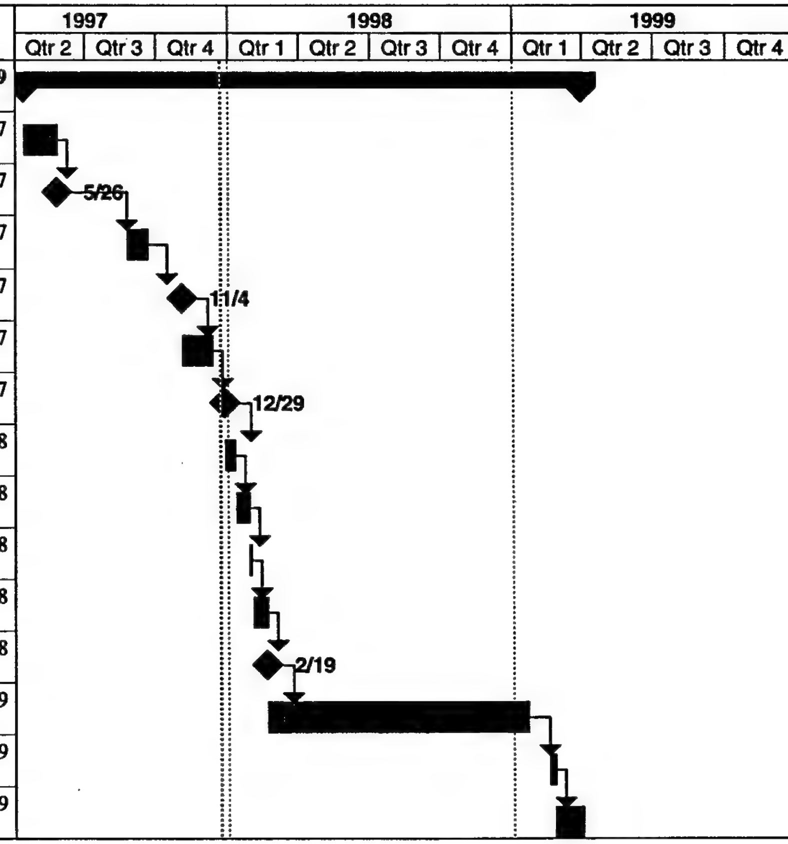
4.5.2 System Monitoring

Monitoring of the bioventing system will include system checks of blower operation, including outlet pressures, inlet vacuum, and exhaust temperature every 2 weeks. These system checks will be performed by Eglin AFB technicians.

Soil samples will be collected from all boreholes advanced during drilling activities for installation of the full-scale bioventing system components. Samples will be collected at 5-foot intervals, and will be screened in the field for organic vapors using a OVA. Five soil samples will be sent to an analytical laboratory for analysis of BTEX by USEPA Method SW8020 and TRPH by USEPA Method SW8015 modified. These samples will

Schedule of Activities
Expanded Bioventing System
Eglin Main Base Old FTA, Eglin AFB, Florida

ID	Task Name	Duration	Start	Finish
1	**Eglin Main Base Old FTA**	**509d**	**4/14/97**	**3/31/99**
2	Draft ICM Work Plan Preparation	31d	4/14/97	5/26/97
3	Deliver Draft ICM Work Plan to AFCEE and Eglin AFB	0d	5/26/97	5/26/97
4	Review and Comment	20d	8/25/97	9/19/97
5	Deliver Final ICM Work Plan to AFCEE, Eglin AFB, USEPA, and FDEP	0d	11/4/97	11/4/97
6	Regulatory Review and Comment	29d	11/4/97	12/12/97
7	Regulatory Approval	0d	12/29/97	12/29/97
8	Field Mobilization	8d	12/29/97	1/9/98
9	Construction of System Upgrade	12d	1/12/98	1/27/98
10	System Start-up and Shakedown	3d	1/28/98	1/30/98
11	Preparation of O&M Manual	14d	2/2/98	2/19/98
12	Deliver O&M Manual, Record Drawings, and Letter Results Report to AFCEE and Base	0d	2/19/98	2/19/98
13	O&M Effort	238d	2/20/98	1/19/99
14	One Year Respiration Test and Soil Gas Sampling	5d	2/17/99	2/23/99
15	One Year Monitoring Report	26d	2/24/99	3/31/99



Project:
Date: 12/22/97

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

I:\EGLIN\726876\OLDEGFTA\ICMWP\OLDEGFTA.MPP

Figure 4.2

be collected from the boreholes advanced for the MPs if significant contamination is encountered at these locations.

Soil gas sampling will be conducted at all MPs, all VWs, and selected monitoring wells prior to system startup to establish baseline oxygen, carbon dioxide, and TVH levels using field instruments. Well constuction diagrams for the selected monitoring wells (FT28-03, FT28-04, FT28-05, FT28-07, and IMW6) are provided in Appendix B. In addition, soil gas samples from five locations will be forwarded to an analytical laboratory for analysis of TVH and BTEX by USEPA Method TO-3. The locations of these samples will be determined based on the field screening results. The five intervals exhibiting the highest TVH concentrations based on field instruments will be sampled for laboratory analysis.

Following startup and optimization of the bioventing system, Parsons ES personnel will remain on site to ensure that adequate oxygen influence has been achieved. System performance monitoring by Parsons ES under Option 1 of the Extended Bioventing Project will include *in situ* respiration testing during a site visit after 1 year of full-scale system operation. Soil gas samples will also be collected from the same five points sampled during full-scale system installation and reanalyzed for BTEX and TVH using USEPA Method TO-3. No soil sampling will be performed under Option 1 of the Extended Bioventing Project.

Prior to performing the 1-year respiration tests and soil gas sampling, the blower will be turned off for 30 days to allow soil gas to equilibrate so that 1-year data can be compared to initial soil gas data. Air will be injected into VWs or MPs for approximately 20 hours, and then shut off. Oxygen uptake will be monitored in the MPs for approximately 72 hours to measure the rate at which oxygen decreases in the soil gas. These data will then be used to estimate the current biodegradation rates and to evaluate the progress of contaminant removal and system effectiveness. As the fuel in the soil is depleted, the respiration activity of the indigenous microorganisms is reduced, and slower oxygen utilization rates will be measured. The use of oxygen utilization and soil gas chemistry as indicators of remaining contaminant concentration decreases the likelihood of premature closure soil sampling events.

System monitoring and *in situ* respiration test data will be analyzed to determine the progress of soil remediation. Estimates of contaminant reduction and time remaining to complete soil remediation will be based on the data collected during the respiration tests (oxygen utilization rates), quantitative estimates of the long-term biodegradation rates, and decreases in soil gas concentrations. If soil gas data indicate that the soils have been sufficiently remediated, closure soil sampling may be recommended.

The monitoring schedule for the full-scale system will be as follows:

Event	Frequency
Blower Vacuum/Pressures and Temperatures	Bi-weekly
Respiration Testing	Annually
Soil Gas Sampling	Annually

5. HANDLING OF INVESTIGATION-DERIVED WASTES

All soil cuttings will be containerized in drums staged at the site. Following completion of drilling activities, the Eglin AFB contact will be notified. It is anticipated that less than 9 cubic yards of soil cuttings will be generated during installation of the full-scale bioventing system.

Decontamination of augers, sampling equipment, and all other items requiring decontamination will be performed at a temporary decontamination area set up at the site. Decontamination water will be placed in 55-gallon drums and stored at the site. Eglin AFB will be responsible for ultimate disposal of all the drummed waste.

6. BASE SUPPORT REQUIREMENTS

The following support from Eglin AFB is needed prior to the arrival of the drillers and the Parsons ES team:

- Assistance in obtaining a Base digging permit.
- Obtaining all necessary regulatory permits for the VWs and MPs.
- Assistance in obtaining any air permits required.
- Provide a copy of any Base soils management plan (SMP) and/or sampling and analytical procedures (SAP) plan.
- Provide any paperwork required to obtain gate passes and security badges for drilling personnel and two Parsons ES employees. If required by the Base, vehicle passes will be needed for two Parsons ES trucks, one drill rig, and two drilling support trucks. These passes must be valid for the expected duration of drilling operations (about 1 week) and the full-scale system installation and startup (about 3 weeks).
- A potable water supply for well construction and decontamination activities.

During full-scale bioventing, Base personnel will be required to check the blower systems once every 2 weeks to ensure that they are operating properly, record air injection pressures and temperatures, and replace air filters, as needed. Parsons ES will provide a maintenance procedures manual and a brief training session.

- If the blower stops working, notify Mr. Steve Ratzlaff of Parsons ES at (404) 235-2361, Mr. John Ratz of Parsons ES - Denver at (303) 831-8100, or Major Ed Marchand of AFCEE at (210) 536-4364.
- Arrange site access for a Parsons ES technician to conduct respiration testing and soil gas sampling approximately 1 year after full-scale system installation and start up.

7. POINTS OF CONTACT

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AFDTC/EMR
207 North 2nd Street
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Eglin AFB, Florida 32542-5133
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Fax (904) 882-6848
e-mail: armstrongr@ntserver.eglin.af.mil

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Fax: (303) 831-8208
e-mail: john_ratz@parsons.com

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Fax: (404) 235-2500
e-mail: steve_ratzlaff@parsons.com

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AFCEE/ERT
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(210) 536-4364
Fax: (210) 536-4330
e-mail: emarchan@afceeb1.brooks.af.mil

8. REFERENCES

Downey, D.C. and J.F. Hall, 1994. *Addendum One to Test Plan and Protocol for a field treatability test for Bioventing - Using Soil Gas Surveys to Determine Bioventing Feasibility and Natural Attenuation Potential*, Prepared for the Air Force Center for Environmental Excellence (AFCEE). February.

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Leeson, A. and R.E. Hinchee. 1995. *Principles and Practices of Bioventing: Volume I: - Bioventing Principles; Volume II - Bioventing Design.* Prepared by Battelle Memorial Institute, Columbus, Ohio for the Armstrong Laboratory, Tyndall AFB, Florida, National Risk Management Laboratory, USEPA, Cincinnati, Ohio and U.S. Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks AFB, Texas. September 29.

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APPENDIX A
DESIGN PACKAGE

CONSTRUCTION DRAWINGS FOR

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

PREPARED FOR

AFCEE

OCTOBER 1997

DRAWING INDEX

DRAWING NO	DRAWING NAME
G-0.1	TITLE SHEET AND SITE LAYOUT
G-0.2	LEGEND AND STANDARD TRENCH DETAIL
G-0.3	VENT WELL AND MONITORING POINT STANDARD DETAILS
G-0.4	BLOWER P & ID
G-0.5	BLOWER PIPING LAYOUT DETAIL
G-0.6	BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAIL

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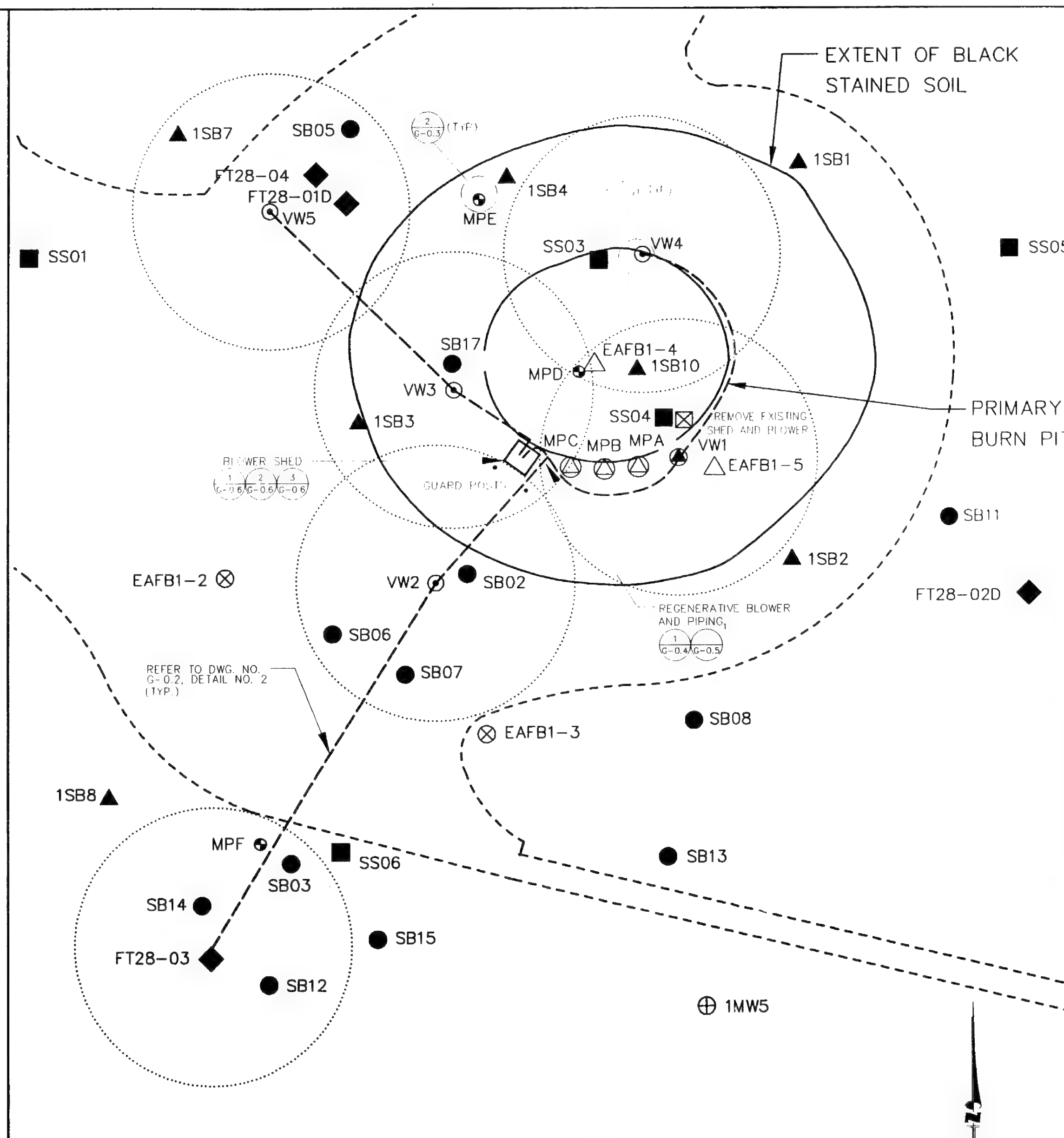

SITE LAYOUT

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Drawn	CPC
Checked	
Reviewed	
Approved	
Reg No	
Date	

Rev	Date	Description	By
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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

TITLE SHEET AND SITE LAYOUT

DRAWING NO **G-0.1** REV **B**

ABBREVIATIONS

AIJ	AIR INJECTION
APPROX	APPROXIMATE
ASTM	AMERICAN SOCIETY OF TESTING AND MATERIALS
&	AND
@	AT
CBM	CENTER BACK MOUNT
CFM	CUBIC FEET PER MINUTE
CLR	CLEAR
DIA	DIAMETER
EB	EXPLORATORY BORING
ECC	ECCENTRIC
EW	EACH WAY
FOT	FLAT ON TOP
FPT	FEMALE PIPE THREAD
FT	FOOT
GALV	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHLENE
ie	FOR EXAMPLE
LM	LOWER MOUNT
MAX	MAXIMUM
MIN	MINIMUM
MP	MONITORING POINT
MPT	MALE PIPE THREAD
NO, #	NUMBER
NPT	NATIONAL PIPE THREAD
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
PVC	POLYVINYL CHLORIDE
PW	PROPOSED WELL
RED	REDUCER
REF	REFERENCE
SCH	SCHEDULE
S	SOCKET
SPVC	SLOTTED POLYVINYL CHLORIDE
ST STL	STAINLESS STEEL
TYP	TYPICAL
UST	UNDERGROUND STORAGE TANK
VW	VENT WELL
W/	WITH
WN	WELD NECK
WWF	WELDED WIRE FABRIC

SYMBOLS

MPA ●	EXISTING BIOVENTING MONITORING POINT
MPD ○	PROPOSED BIOVENTING MONITORING POINT
VW-1 ▲	EXISTING VENT WELL
VW-2 △	PROPOSED VENT WELL
— — — — —	PROPOSED HEADER PIPE TO VENT WELL

SECTION DESIGNATION — SECTION NAME

(A / X) **SECTION CUT**

SCALE: NTS

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DETAIL NO — DETAIL NAME

(1 / X) **DETAIL DESCRIPTION**

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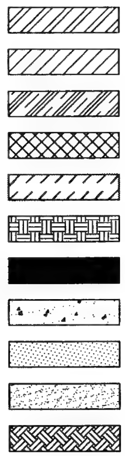
MATERIAL LEGEND



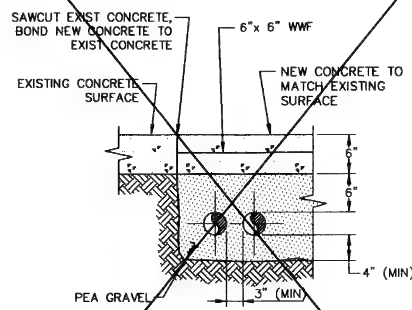
ASPHALT
BENTONITE
BENTONITE/CEMENT GROUT
BENTONITE PELLETS
BUILDING (EXISTING)
COMPACTED BACKFILL
COMPACTED BASE STONE
CONCRETE
PEA GRAVEL
SAND
UNDISTURBED SOIL

PIPE MATERIAL

CS	CARBON STEEL
GALV	GALVANIZED STEEL
PVC	POLYVINYL CHLORIDE
SPVC	SCREENED POLYVINYL CHLORIDE

PIPE SERVICE

AIJ	AIR INJECTION
BIV	BIOVENTING
DR	DRAIN



(1 / –) CONCRETE REPLACEMENT DETAIL

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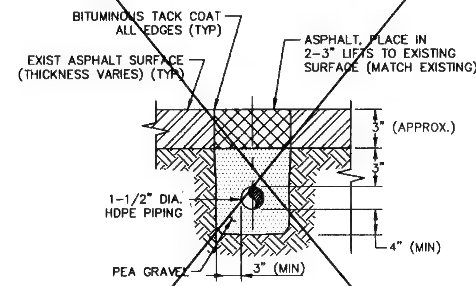

(2 / –) ASPHALT REPLACEMENT DETAIL

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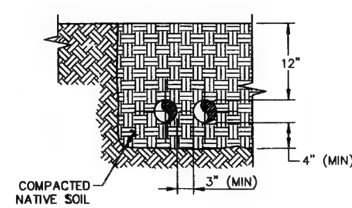

(3 / –) SOIL COVER REPLACEMENT DETAIL

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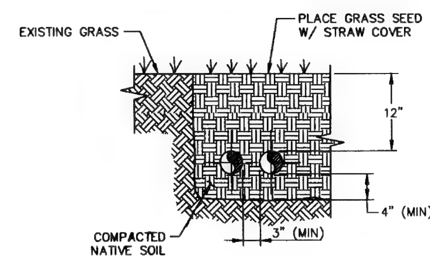

(4 / –) GRASS COVER REPLACEMENT DETAIL

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Reg No	A	5/22/97	65% DESIGN
Date	Rev	Date	Description / By

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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

LEGEND AND STANDARD TRENCH DETAILS

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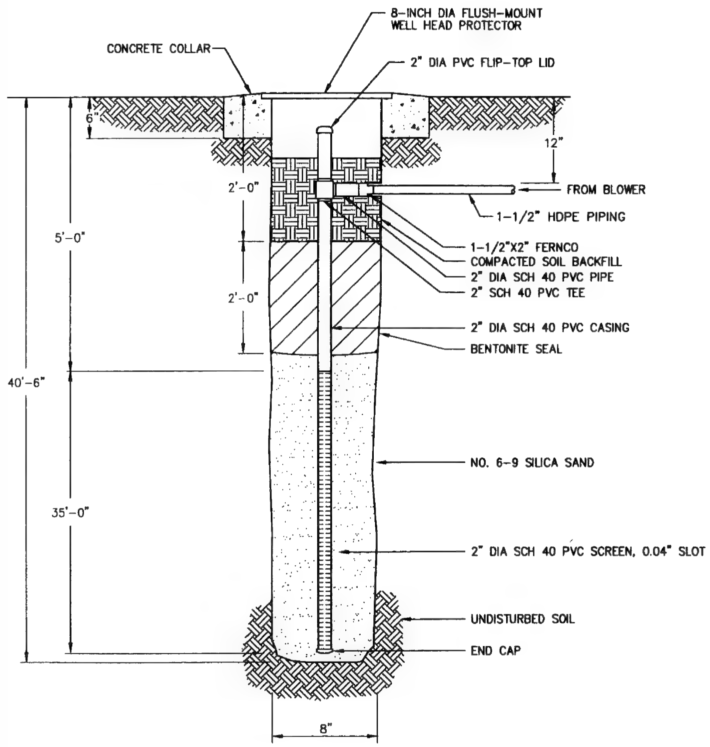

1 — VENT WELL (VW) DETAIL

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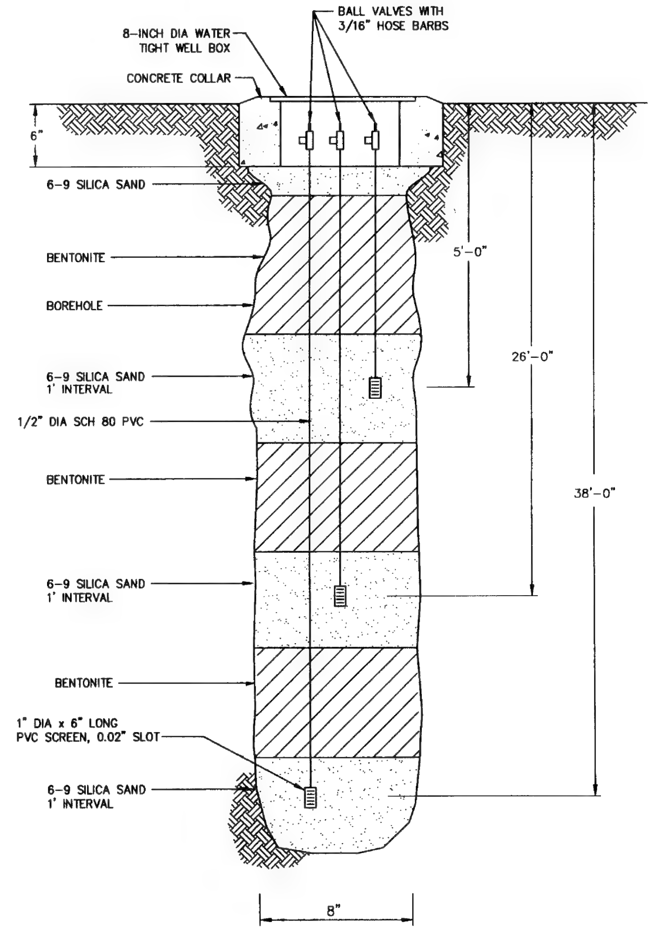

2 — MONITORING POINT (MP) DETAIL

SCALE: NTS

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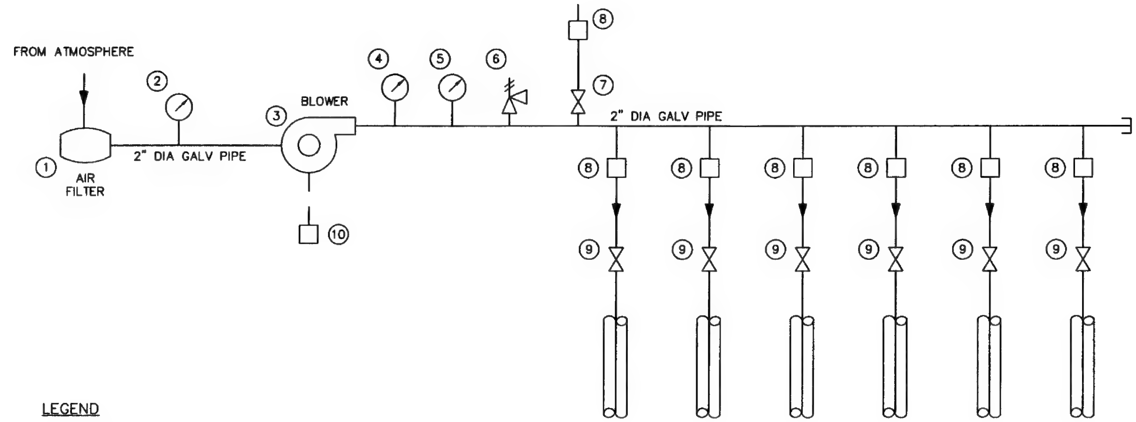
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

VENT WELL AND MONITORING POINT STANDARD DETAILS

DRAWING NO **G-0.3** REV **A**



LEGEND

1. INLET AIR FILTER – SOLBERG F-30S-200, REPLACEMENT ELEMENT 30S
2. VACUUM GAUGE – GAST® 2 5/8" DIA, 0-60" H_2O, 1/4" NPT, LM (Part No. AJ497)
3. BLOWER – GAST® 3.0 HP R6130Q-50, 200 CFM AT 10" H_2O PRESSURE
4. TEMPERATURE GAUGE – ASHCROFT, 0-250°F, 1/2" NPT, CBM (Part No. 2A606 FROM GRAINGER)
5. PRESSURE GAUGE – WIKA 611.10, 2 1/2" DIA., 0-60" H_2O, 1/4" NPT, LM (Part No. 9851704)
6. AUTOMATIC PRESSURE RELIEF VALVE – GAST AG258, SET TO RELEASE AT 40" H_2O PRESSURE
7. MANUAL PRESSURE RELIEF (BLEED) VALVE – 1 1/2" GATE
8. FLOW MEASURING PORT FITTED WITH PLUG (1/4" x 1/8" NPT BRASS REDUCING BUSHING, 1/8" NPT BRASS PLUG)
9. FLOW CONTROL VALVE – 1 1/2" GATE
10. STARTER

NOTES

1. ALL PIPING 1 1/2" DIAMETER, GALVANIZED STEEL, UNLESS OTHERWISE NOTED.

1 BLOWER PIPING AND INSTRUMENTATION DIAGRAM

SCALE: NTS

Job No. 726876.43242				
Designed SAR				
Drawn OPC				
Checked				
Reviewed				
Approved				
Reg No	A	5/22/97	65% DESIGN	
Date	Rev	Date	Description	By

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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

BLOWER P & ID

DRAWING NO G-0.4 REV A

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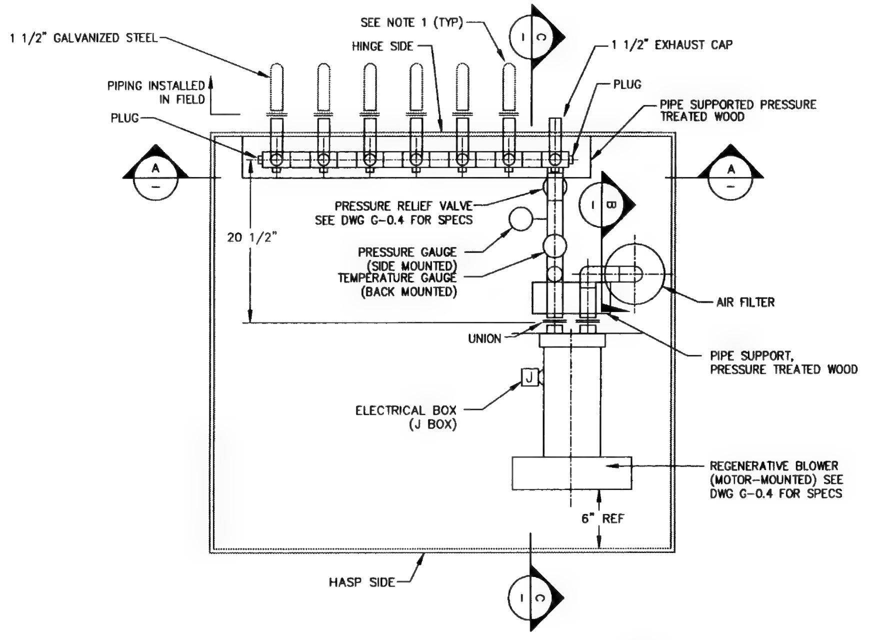
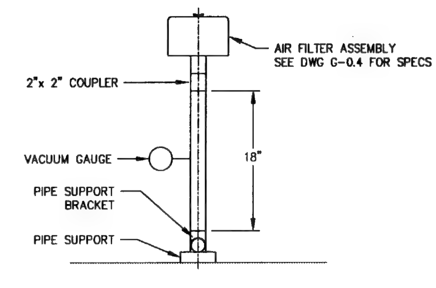


1 BLOWER PIPING LAYOUT PLAN DETAIL

3/4" = 1'-0"

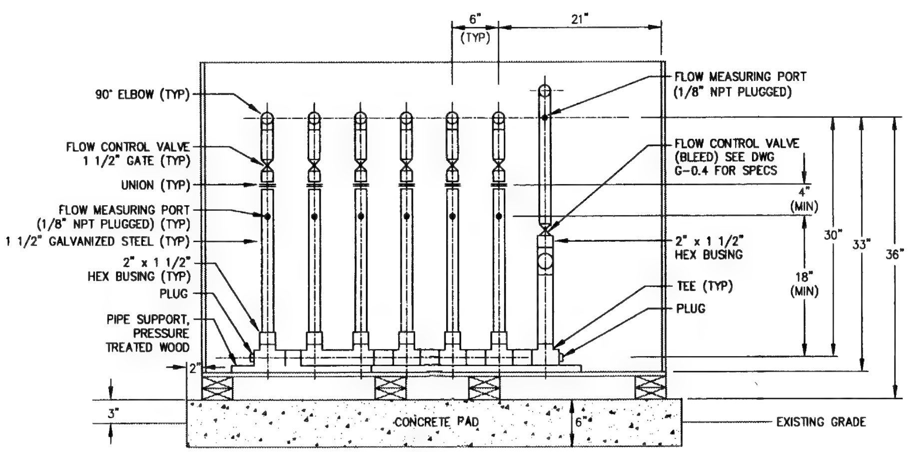
NOTES:

1. SHOP CORE HOLES TO PIPING DIMENSIONS
2. ALL PIPING 2" DIA. GALVANIZED STEEL, UNLESS OTHERWISE NOTED
3. SEE DRAWING G-0.6 FOR BLOWER BUILDING DETAILS



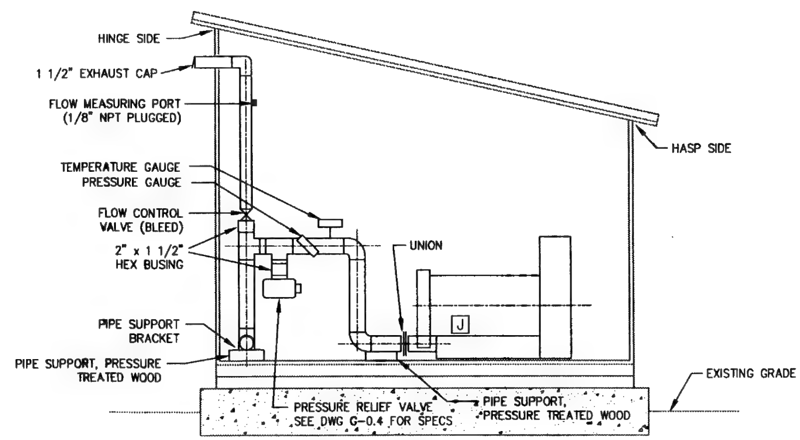
B BLOWER INLET PIPING SECTION

3/4" = 1'-0"



A MANIFOLD DETAIL SECTION

3/4" = 1'-0"



C BLOWER OUTLET PIPING SECTION

3/4" = 1'-0"

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Drawn CPC			
Checked			
Reviewed			
Approved			
Reg No	A	5/22/97	65% DESIGN
Date	Rev	Date	Description	By

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AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)

EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASES OLD FTA
EGLIN AIR FORCE BASE

BLOWER PIPING LAYOUT DETAIL

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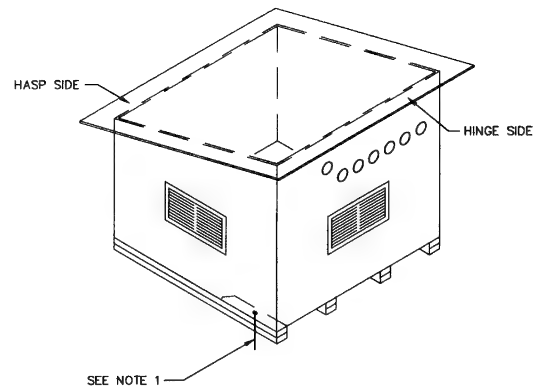
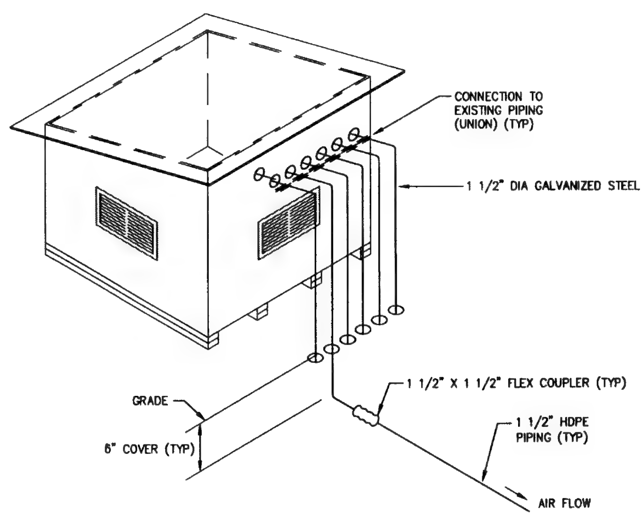


NOTE:

1. FIELD SECURE BLOWER SHED TO CONCRETE PAD AT LOCATIONS BY THRU BOLTING. USE 3/8"x 6" LONG ST STL WEDGE ANCHOR BOLTS, 4 PLACES

1 BLOWER SHED FIELD INSTALLATION DETAIL

NOT TO SCALE



2 TYPICAL MANIFOLD DISCHARGE PIPING LAYOUT

NOT TO SCALE

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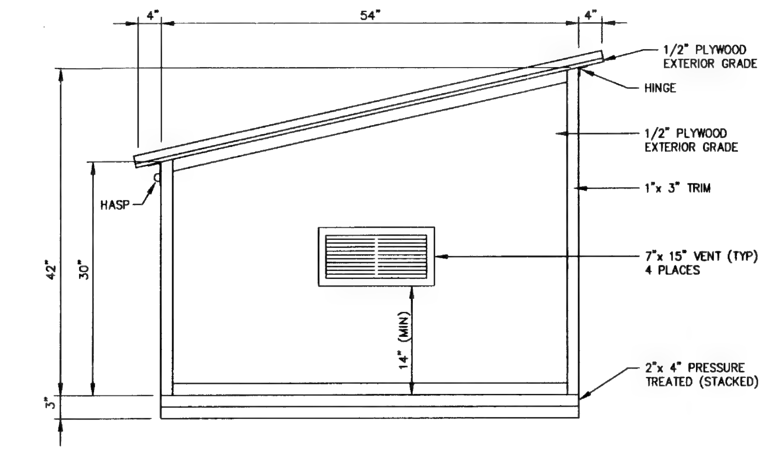
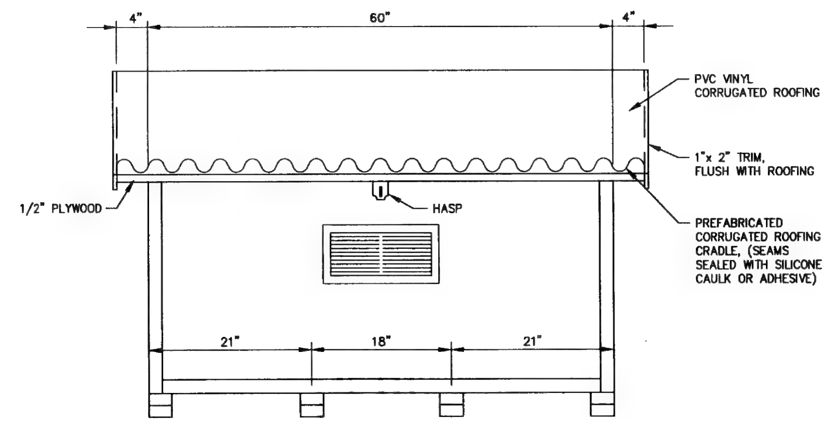


SIDE ELEVATION



FRONT ELEVATION

NOTES:

1. 2"x 2" FRAME CONSTRUCTION
2. FLOOR CONSTRUCTED OF 3/4" EXTERIOR GRADE PLYWOOD
3. ROOF CONSTRUCTED OF 1/2" EXTERIOR GRADE PLYWOOD COVERED WITH PVC VINYL CORRUGATED ROOFING

3 BLOWER SHED CONSTRUCTION DETAIL

3/4" = 1'-0"

Job No. 726876.43242			
Designed SAR			
Drawn CPC			
Checked			
Reviewed			
Approved			
Reg No	A	5/22/97	65% DESIGN
Date	Rev	Date	Description	By

PARSONS ENGINEERING SCIENCE, INC.
Atlanta, Georgia (404) 235-2300

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
EXPANDED BIOVENTING SYSTEM
EGLIN MAIN BASE OLD FTA
EGLIN AIR FORCE BASE

BLOWER SHED FIELD INSTALLATION DETAIL AND BLOWER SHED CONSTRUCTION DETAILS

DRAWING NO G-0.6 | REV A

APPENDIX B
WELL CONSTRUCTION DIAGRAMS

Location: Eglin AFB	Site: FT28-03
Elevation: 70.40'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 11/11/94 - 11/11/94
Logged By: FJ Ferreira	Consulting Firm: O'Brien & Gere
Contractor: PSI	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 47.00'	X Coordinate: 1332190
Well Construction:	Y Coordinate: 543373

Well Construction:

Casing
type: PVC dia: 2.00" fm: -2.8' to: 37.00'

Screens:
type: Slotted size: .010" dia: 2.00" fm: 37.00' to: 47.00'

Annular Fill:

type	fm	to
type: Grout	fm: .00'	to: 33.00'
type: Bentonite Pellets	fm: 33.00'	to: 35.00'
type: Sand Filter	fm: 35.00'	to: 47.50'

Remarks: BG = Background

MP. EL. 73.20

Depth (ft)	Sample No.	Blow Count	Material Description	PID	USCS Code
	1	NA NA NA NA	Yellowish brown (10YR 5/6), damp, medium SAND, little fine and coarse sand, subrounded, quartz, some shells from 0-1'.	BG ppm	SW
	2	NA NA NA NA	Yellowish brown (10YR 5/6), damp, medium SAND, little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
	3	6 6 11 12	Brownish yellow (10YR 6/6), damp, medium dense, medium SAND, little fine and coarse sand, subrounded, quartz, some shells from 0-1'.	BG ppm	SW
	4	11 12 9 21	Yellow (10YR 7/8), damp, medium dense, medium SAND, little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	S
	5	4 6 9 9	Yellow (10YR 7/6), damp, medium dense, medium SAND, little fine and coarse sand, subrounded, quartz.	0.1 ppm	SW
10	6	9 11 13 20	Yellow (2.5Y 7/6), damp, medium dense, medium SAND, little fine and coarse sand, subrounded, quartz.	0.1 ppm	SW
	7	7 10 15 20	Yellow (2.5Y 7/6), damp, medium dense, medium SAND, some to little fine sand, little to trace coarse sand, subrounded, quartz.	BG ppm	SW
20	8	14 25 30 20	Yellow (2.5Y 8/6), damp, very dense, medium SAND, little fine sand, little to trace coarse sand, subrounded, quartz.	0.1 ppm	SW
	9	11 13 16 17	Light yellowish brown (2.5Y 6/4), damp to moist, medium dense, medium SAND, some to little fine sand, little to trace very fine and coarse sand, subrounded, quartz.	BG ppm	SW

Location: Eglin AFB	Site: FT28-03
Elevation: 70.40'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 11/11/94 – 11/11/94
Logged By: FJ Ferreira	Consulting Firm: O'Brien & Gere
Contractor: PSI	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 47.00'	X Coordinate: 1332190
Well Construction:	Y Coordinate: 543373
Casing type: PVC dia: 2.00" fm: −2.8' to: 37.00' Screens: type: Slotted size: .010" dia: 2.00" fm: 37.00' to: 47.00'	Annular Fill: type: Grout fm: .00' to: 33.00' type: Bentonite Pellets fm: 33.00' to: 35.00' type: Sand Filter fm: 35.00' to: 47.50' Remarks: BG = Background

Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	Material Description	PID	USCS Code
		10	14 18 18 25		Brown (10YR 4/3), moist, dense, medium SAND, some to little fine sand, little to trace coarse sand, subrounded, quartz.	0.4 ppm	SW
		11	13 34 38 50		White (10YR 8/1), moist, very dense, coarse SAND, some medium sand, subrounded, quartz, fuel odor.	208.5 ppm	SW
40		12	19 24 34 46		Very dark gray (10YR 3/1), saturated, very dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz, strong fuel odor.	378.6 ppm	SW
		13	17 26 31 40		Dark brown (10YR 3/3), saturated, very dense, medium SAND, some to little fine sand, little to trace coarse sand, subrounded, quartz, strong petroleum odor and sheen on soil.	335.6 ppm	SW
50							

Location: Eglin AFB	Site: FT28-04
Elevation: 67.10'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 11/16/94 – 11/17/94
Logged By: FJ Ferreira	Consulting Firm: O'Brien & Gere
Contractor: PSI	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 45.00'	X Coordinate: 1332249

Well Construction:

Casing
type: PVC dia: 2.00" fm: -3.0' to: 35.00'

Screens:
type: Slotted size: .010" dia: 2.00" fm: 35.00' to: 45.00'

Y Coordinate: 543703

Annular Fill:

type	fm	to
Grout	.00'	31.00'
Bentonite Pellets	31.00'	33.00'
Sand Filter	33.00'	45.50'

Remarks: BG = Background

MP. EL. 70.11

Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	Material Description	PID	USCS Code
		1	NA NA NA NA	o	Yellowish brown (10YR 5/6), moist, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		2	NA NA NA NA	o	Yellow (2.5Y 7/6), damp, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz, oily soil from 2-3', strong fuel odor.	277.9 ppm	SW
		3	7 13 13 14	o	Yellow (10YR 7/6), damp, medium dense, medium SAND, some to little fine sand, little to trace coarse sand, subrounded, quartz, oil stained, strong fuel odor.	488.2 ppm	SW
		4	6 6 50/4	o	Black (10YR 2/1), damp, very dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz, oil stained, strong petroleum odor.	667.9 ppm	
		5	3 4 4 5	o	Yellowish brown (10YR 5/4), moist, loose, COARSE SAND and medium sand, little to trace fine sand, subrounded, quartz, some oil stains, fuel odor.	113.7 ppm	SW
10		6	4 5 6 6	o	Yellow (10YR 7/6), moist, medium dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz, some oily stains, fuel? odor.	22.7 ppm	SW
		7	3 3 4 6	o	Yellow (10YR 7/6), moist, loose, medium SAND, some to little fine and coarse sand, subrounded, quartz, very slight fuel odor.	12.6 ppm	SW
		8	3 4 4 4	o	Yellow (10YR 7/6), moist, loose, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz.	9.8 ppm	SW
		9	4 7 8 8	o	Yellow (10YR 7/8), moist, medium dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz.	13.1 ppm	SW
		10	4 7 7 9	o	Yellow (10YR 7/6), moist, medium dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz.	9.8 ppm	SW
20		11	7 8 9 9	o	Yellow (10YR 7/6), moist, medium dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz.	11.5 ppm	SW
		12	7 13 14 17	o	Yellow (2.5Y 8/6), moist, medium dense, medium SAND, some coarse sand, trace fine sand, subrounded, quartz.	3.7 ppm	SW
		13	8 5 22 26	o	Pale yellow (2.5Y 8/2), moist, medium dense, medium SAND, little to trace fine and coarse sand, rounded to subrounded, quartz, slight odor.	28.8 ppm	SW
		14	9 17 20 22	o	Pale yellow (2.5Y 7/3), moist, dense, medium SAND, some coarse sand, trace fine sand, subrounded, quartz, unknown odor.	28.3 ppm	SW
		15	17 21 26 34	o	Very pale brown (10YR 8/4), moist, dense, coarse SAND, some medium sand, subrounded, quartz, fuel odor.	61.3 ppm	SW

Location: Eglin AFB	Site: FT28-04
Elevation: 67.10'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 11/16/94 – 11/17/94
Logged By: FJ Ferreira	Consulting Firm: O'Brien & Gere
Contractor: PSI	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 45.00'	X Coordinate: 1332249
	Y Coordinate: 543703

Well Construction:

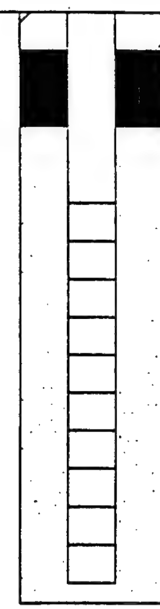
Casing type: PVC		dia: 2.00"	fm: -3.0'	to: 35.00'
Screens type: Slotted	size: .010"	dia: 2.00"	fm: 35.00'	to: 45.00'

Annular Fill:

type: Grout	fm: .00'	to: 31.00'
type: Bentonite Pellets	fm: 31.00'	to: 33.00'
type: Sand Filter	fm: 33.00'	to: 45.50'

Remarks: BG = Background

Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	Material Description	PID	USCS Code
		16	16 20 24 27	o	Light brown (7.5YR 6/4), moist, dense, coarse SAND, some medium sand, little to trace fine sand, subrounded, quartz, unknown odor.	20 ppm	SW
		17	18 32 36 48	o	Very pale brown (10YR 8/4), moist, very dense, COARSE SAND and medium sand, little to trace fine sand, subrounded, quartz, unknown odor.	30.1 ppm	SW
		18	19 28 39 47	o	Very pale brown (10YR 8/4), moist to saturated, very dense, coarse SAND, some medium sand, little to trace fine sand, subrounded, quartz, unknown odor.	42.6 ppm	SW
		19	11 26 29 34	o	Very dark grayish brown (10YR 3/2), saturated, very dense, coarse SAND, some medium sand, trace fine sand, subrounded, quartz, fuel odor.	52.7 ppm	
		20	10 26 27 31	o	Very dark grayish brown (10YR 3/2), saturated, very dense, coarse SAND, some medium sand, trace fine sand, subrounded, quartz, fuel odor.	39.5 ppm	SW
40		21	17 29 33 46	o	Dark brown (10YR 3/3), saturated, very dense, coarse SAND, some medium sand, trace fine sand, subrounded, quartz, fuel odor.	41.6 ppm	SW
		22	11 18 20 22	o	Dark brown (10YR 3/3), saturated, dense, coarse SAND, some to little medium sand, little to trace fine sand, subrounded, quartz, fuel odor.	14.9 ppm	SW
50							



Location: Eglin AFB	Site: FT28-05
Elevation: 68.80'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 12/02/94 - 12/02/94
Logged By: FJ Ferriera	Consulting Firm: O'Brien & Gere
Contractor: PSI	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 45.00'	X Coordinate: 1332124
	Y Coordinate: 543829

Well Construction:

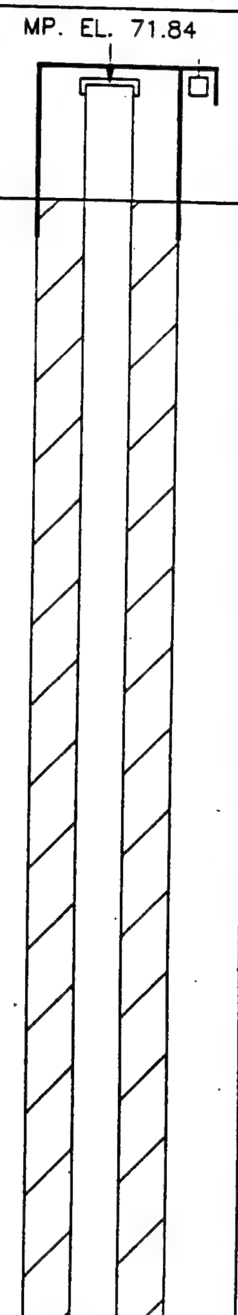
Casing type	size	dia	fm	to
PVC		2.00"	-3.0'	35.00'

Screens type	size	dia	fm	to
Slotted	.010"	2.00"	35.00'	45.00'

Annular Fill:

type	fm	to
Grout	.00'	30.50'
Bentonite Pellets	30.50'	32.50'
Sand Filter	32.50'	45.50'

Remarks: BG = Background



Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	Material Description	PID	USCS Code
		1	NA NA NA NA	o	Yellowish brown (10YR 5/6), damp, medium SAND, some coarse sand, some to little fine sand, rounded to subrounded, quartz.	BG ppm	SW
		2	NA NA NA NA	o	Brownish yellow (10YR 6/6), damp, medium SAND, little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		3	3 10 10 10	o	Brownish yellow (10YR 6/8), damp, medium dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz, with tiny black specks.	2.4 ppm	SW
		4	4 5 9 17	o	Brownish yellow (10YR 6/8), damp, medium dense, medium SAND, some coarse sand, trace fine sand, subrounded, quartz, very slight odor.	26.8 ppm	-
		5	4 5 6 12	o	Yellow (10YR 7/8), damp, medium dense, medium SAND, some coarse sand, trace fine sand, subrounded, quartz.	0.4 ppm	SW
10		6	5 5 5 12	o	Yellowish brown (10YR 5/8), damp, medium dense, medium SAND, little to trace fine and coarse sand, subrounded, quartz.	BG ppm	SW
		7	6 6 8 11	o	Yellowish brown (10YR 5/8), damp, medium dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		8	5 6 12 13	o	Yellow (10YR 8/6), damp, medium dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		9	6 10 11 11	o	Yellow (10YR 8/6), damp, medium dense, medium SAND, some to little coarse sand, little to trace fine sand, rounded to subrounded, quartz.	BG ppm	SW
		10	7 9 9 12	o	Yellow (10YR 7/8), damp, medium dense, medium SAND, some coarse sand, trace fine sand, subrounded, quartz.	BG ppm	SW
20		11	8 14 14 18	o	Yellow (10YR 8/8), damp, medium dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz.	4.6 ppm	SW
		12	15 24 28 32	o	Yellow (10YR 8/8), damp, very dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		13	25 32 50/6	o	Yellow (10YR 8/8), damp, extremely dense, medium SAND, little coarse sand, little to trace fine sand, subrounded, quartz.	4.4 ppm	SW
		14	16 26 36 48	o	Yellow (10YR 8/6), damp, very dense, medium SAND, some to little fine and coarse sand, subrounded, quartz.	BG ppm	SW
		15	19 28 39 41	o	Yellow (10YR 8/6), damp, very dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW

Location: Eglin AFB	Site: FT28-05
Elevation: 68.80'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 12/02/94 - 12/02/94
Logged By: FJ Ferriera	Consulting Firm: O'Brien & Gere
Contractor: PSI	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 45.00'	X Coordinate: 1332124
Well Construction:	Y Coordinate: 543829

Well Construction:

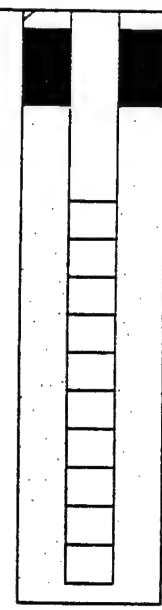
Casing
type: PVC dia: 2.00" fm: -3.0' to: 35.00'

Screens:
type: Slotted size: .010" dia: 2.00" fm: 35.00' to: 45.00'

Annular Fill:
type: Grout fm: .00' to: 30.50'
type: Bentonite Pellets fm: 30.50' to: 32.50'
type: Sand Filter fm: 32.50' to: 45.50'

Remarks: BG = Background

Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	Material Description	PID	USCS Code
		16	28 46 50/4	o	Yellow (2.5Y 7/6), damp, extremely dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		17	33 43 50/3	o	Pale yellow (2.5Y 8/4), damp, extremely dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		18	24 50 50/6	o	Pale yellow (2.5Y 8/4), damp to moist, extremely dense, medium SAND, some coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
		19	44 48 50/6	o	Pale yellow (2.5Y 8/4), saturated, extremely dense, medium SAND, some to little coarse sand, little to trace fine sand, rounded to subrounded, quartz.	BG ppm	S
		20	39 48 50/6	o	Pale yellow (2.5Y 8/3), saturated, extremely dense, medium SAND, some to little coarse sand, little to trace fine sand, rounded to subrounded, quartz.	BG ppm	SW
40		21	40 40 47 50/3	o	White (2.5Y 8/1), saturated, extremely dense, medium SAND, little fine and coarse sand, rounded to subrounded, quartz.	BG ppm	SW
		22	29 46 50/4	o	White (10YR 8/1), saturated, extremely dense, medium SAND, some coarse sand, trace fine sand, subrounded, quartz.	BG ppm	SW
		23	38 48 49 50/2	o	White (10YR 8/1), saturated, extremely dense, medium SAND, some to little coarse sand, little to trace fine sand, subrounded, quartz.	BG ppm	SW
50							



Location: Eglin AFB	Site: FT28-07
Elevation: 67.40'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 11/13/95 - 11/13/95
Logged By: BD Clabaugh	Consulting Firm: O'Brien & Gere
Contractor: Kelly Env. Drilling	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 41.00'	X Coordinate: 1331944
Well Construction:	Y Coordinate: 543710

Well Construction:

Casing
type: PVC dia: 2.00" fm: 0.1' to: 31.00'

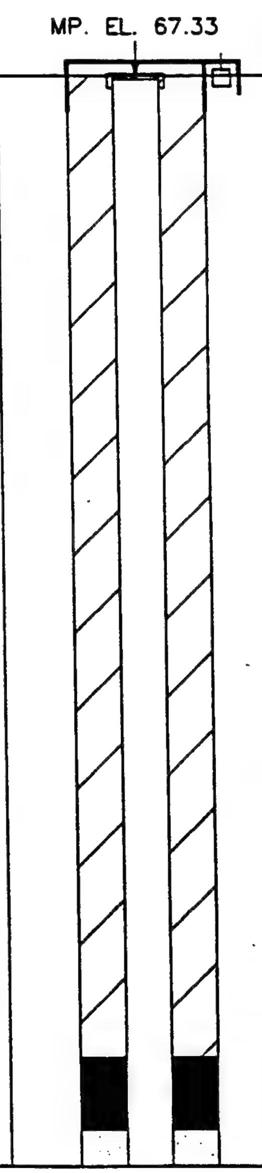
Screens:
type: Slotted size: .010" dia: 2.00" fm: 31.00' to: 41.00'

Annular Fill:

type	fm	to
Grout	.00'	27.00'
Bentonite Pellets	27.00'	29.00'
Sand Filter	29.00'	41.00'

Remarks:

Depth (ft)	Recovery	Sample No.	Blow Count	Graphic Log	Material Description	PID	USCS Code
		1	NA NA NA NA		Light brown (5YR 5/6), damp, loose, well sorted, fine to medium SAND		SP
10		2	3 3 4 5		Pale yellowish brown (10YR 4/2), damp, loose, well sorted, fine to medium SAND for 0.25', then grayish orange (10YR 7/4)	1.7 ppm	SP
		3	2 3 4 5		Pale yellowish orange (10YR 8/6), damp, medium dense, well sorted, fine to medium SAND, subrounded	2.8 ppm	SP
20		4	3 6 7 10		Pale yellowish orange (10YR 8/6), damp, dense, fine to medium SAND for 1.5', then pale yellowish brown (10YR 6/2), damp, dense, fine to medium SAND, trace silt	10.1 ppm	SP
		5	3 8 12 16		Moderate yellowish brown (10YR 5/4), damp, dense, well sorted, fine to medium SAND, subrounded	22.5 ppm	SP



Location: Eglin AFB	Site: FT28-07
Elevation: 67.40'	Purpose: Monitoring Well, Shallow
Datum: Mean Sea Level	Date(s): 11/13/95 - 11/13/95
Logged By: BD Clabaugh	Consulting Firm: O'Brien & Gere
Contractor: Kelly Env. Drilling	Drilling Method: HSA (10.25 inches O.D.)
Completed Depth: 41.00'	X Coordinate: 1331944
	Y Coordinate: 543710

Well Construction:

Casing type: PVC — dia: 2.00" fm: 0.1' to: 31.00'

Screens: type: Slotted — size: .010" dia: 2.00" fm: 31.00' to: 41.00'

Annular Fill:

type	fm	to
Grout	.00'	27.00'
Bentonite Pellets	27.00'	29.00'
Sand Filter	29.00'	41.00'

Remarks:

Depth (ft)	Sample No.	Blow Count	Material Description	PID	USCS Code
	6	3 10 15 21	Moderate yellowish brown (10YR 5/4), wet, dense, medium SAND Water encountered at 34'	17.3 ppm	SP
	7	5 10 14 23	Pale yellowish brown (10YR 6/2), saturated, dense, medium SAND for 0.5', then fine to medium sand	26.5 ppm	SP
40	8	[illegible]	Pale yellowish brown (10YR 6/2), saturated, dense, medium SAND	7.5 ppm	SP
	9				
50					

DRILLING AND WELL COMPLETION RECORD

JOB NAME/LOCATION EGLIN FIRE TRAINING AREA PAGE 1 OF 2
WELL/BORING LOCATION EG3-1MW6 PROJECT I.D. AT 138
COORDINATES 1,363,512.74 E. 543,429.44 N DRILLING STARTED 4/21/88
ES GEOLOGIST/ENGINEER ERICA BRANDT WELL DIAMETER 2 IN.
DRILLER: GRAVES/JERRY DRILLING METHOD HOLLOW STEM AUGERS
DRILLING COMPLETED 4/21/88 WELL COMPLETED 4/21/88 TOTAL WELL DEPTH 48 FT
SCREENED INTERVALS 38-48 FT TOTAL BOREHOLE DEPTH 50 FT
SAMPLING METHOD SPLIT SPOON M.P. ELEV. 70.72 FT L.S. ELEV. 68.3 FT
WATER LEVEL, Ft BELOW M.P. 44.12 ELEVATION 26.60 FT DATE 7/21/88

DEPTH BELOW L.S.	HNU/OVA	% REC	NO. BLOWS	SAMPLE DESCRIPTION	LITHOLOGY	WELL CONSTRUCTION
0		20in./24in.	--	SAND, medium, yellowish brown, no fuel odor or discoloration		
5		20in./24in.	--	SAND, medium, yellowish brown, no fuel odor or discoloration		
10		24in./24in.	--	SAND, medium, pale yellowish brown, no fuel odor or discoloration		
15						
20		24in./24in.	--	SAND, medium, trace of clay, pale yellowish brown to yellowish brown, no fuel odor or discoloration		
25						

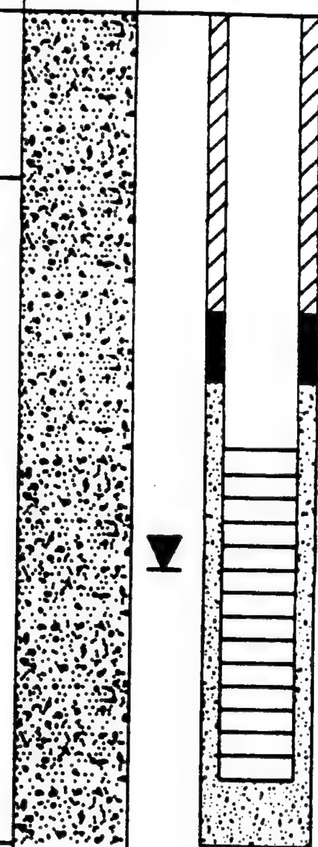
ENGINEERING-SCIENCE, INC.

DRILLING AND WELL COMPLETION RECORD

JOB NAME/LOCATION: EGLIN FIRE TRAINING AREA — PAGE 2 OF 2
WELL/BORING LOCATION: EG3-1MW6 — PROJECT I.D.: AT 138
COORDINATES: 1,363,512.74 E. 543,429.44 N — DRILLING STARTED: 4/24/88
ES GEOLOGIST/ENGINEER: ERICA BRANDT — SIGNATURE:

DEPTH BELOW L.S.	HNU/ OVA	% REC	NO. BLOWS	SAMPLE DESCRIPTION
				DESCRIPTION ON PREVIOUS PAGE
30		24in./24in.	--	SAND, medium, pale yellowish brown to pale brown, no fuel odor or discoloration
35				
40		18in./24in.	--	SAND, very moist
45				
50				BORING TERMINATED AT 50' FT.
55				
60				

LITHOLOGY / WELL CONSTRUCTION:



ENGINEERING-SCIENCE, INC.

ENGINEERING-SCIENCE
DRILLING RECORD

WELL/BORING ID:	EAFB 1-2	DRILLING STARTED:	10/10/86
LOCATION:	FTA-Eglin AFB	DRILLING COMPLETED:	10/17/86
PROJECT NO:	AT002	DRILLING METHOD:	Mud Rotary
DRILLER:	Environmental Laboratories, Inc.	SAMPLING METHOD:	Grab
LOGGER:		STATIC WATER LEVEL:	46.48'
GEOLOGIST:	Ola A. Awosika	WATER LEVEL DATE:	10/23/86
SIGNATURE:		WATER LEVEL DATUM:	24.63' MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
0				SAND - medium grained, light brown	
3				SAND - fine to very fine grained, brown to tan, minor clay content	
6				SAND - medium to fine grained, tan	
9				SAND - medium to fine grained, tan	
12				SAND - medium to fine grained, tan	
15				SAND - medium to fine grained, light brown	
18				SAND - fine grained, light brown	Drilling activity stopped due to rig breakdown (10/10/86)
21				SAND - medium to fine grained, tan to light brown	Drilling activity continued (10/17/86)
24				SAND - medium to fine grained, tan to light brown	
27				SAND - fine grained, tan to light brown	

ENGINEERING-SCIENCE

DRILLING RECORD

WELL/BORING ID: EAFB 1-2	DRILLING STARTED: 10/10/86
LOCATION: FTA-Eglin AFB	DRILLING COMPLETED: 10/17/86
PROJECT NO: AT002	DRILLING METHOD: Mud Rotary
DRILLER: Environmental Laboratories, Inc.	SAMPLING METHOD: Grab
LOGGER:	STATIC WATER LEVEL: 46.48'
GEOLOGIST: Ola A. Awosika	WATER LEVEL DATE: 10/23/86
SIGNATURE:	WATER LEVEL DATUM: 24.63' MSL

DEPTH IN FEET BELOW LS.	SAMPLER BLOWS	PERCENT RECOVERY	SAMPLE ID	SAMPLE DESCRIPTION	NOTES
30				SAND - coarse to fine grained, tan to brown	
33				SAND - coarse to fine grained, dark tan to brown	
36				SAND - medium to fine grained, brown	
39				SAND - medium to fine grained, brown	
42				SAND - fine to very fine grained, brown to dark brown	
45				SAND - medium to fine grained, brown	
48				SAND - fine to very fine grained, brown	
				BT @ 52' 20 ft. screen (.010 slot) - 51' to 31', sand to 29', bentonite to 27', grout to the surface	

APPENDIX C
PROGRAM HEALTH AND SAFETY PLAN FOR EXTENDED BIOVENTING

Program Health and Safety Plan for Extended Bioventing

Prepared For

Air Force Center for Environmental Excellence
Brooks Air Force Base
San Antonio, Texas

May 1995

PARSONS
ENGINEERING SCIENCE, INC.

1700 Broadway, Suite 900 • Denver, Colorado 80290

PROGRAM HEALTH AND SAFETY PLAN
FOR
EXTENDED BIOVENTING

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE (AFCEE)
ENVIRONMENTAL RESTORATION TECHNOLOGY (ERT)
BROOKS AIR FORCE BASE, TEXAS 78235-5000

USAF CONTRACT 41624-92-D-8036, DELIVERY ORDER 17

April 1995

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Reviewed and Approved By:

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Office H & S Representative	Timothy S Mustard	4/25/95

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CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

LIST OF TABLES

LIST OF FIGURES

SECTION 1

PURPOSE AND POLICY

The purpose of this program health and safety plan is to establish personnel protection standards and mandatory safety practices for all Parsons Engineering Science, Inc. (Parsons ES) and subcontractor personnel involved in the bioventing monitoring and full-scale design program at numerous US Air Force sites. Parsons ES has prepared this program health and safety plan to complete the extended bioventing program at U.S. Air Force sites contaminated with petroleum hydrocarbons. The plan also provides for contingencies that may arise during field operations. All Parsons ES personnel and subcontractors who engage in field activities will be familiar with this plan and comply with its requirements. This plan provides guidance for general operations on bioventing sites. Site-specific information is not provided in this plan and will be addressed in formal health and safety plan addenda.

A project description and scope of work summary for the project are provided in Section 2. Section 3 presents the project team organization, personnel responsibilities, and lines of authority. Training and medical monitoring requirements are contained in Section 4. Section 5 presents a safety and health risk analysis. Section 6 contains the program emergency response plan. Program requirements for levels of protection are included in Section 7, and air monitoring procedures are provided in Section 8. Site control measures, including designation of site work zones, are contained in Section 9, while Section 10 provides decontamination procedures. Section 11 contains information on the use and calibration of air monitoring equipment. Appendix A contains an example of an Emergency Contacts Form to be used in each formal health and safety plan addenda prepared for all U.S. Air Force Bioventing sites. Appendix B contains a Plan Acceptance Form, Site Specific Training Records, Personal Air Sampling Data Form, Accident Report Form, Daily Health and Safety Report Form, Self Contained Breathing Apparatus (SCBA) Log Forms, and Respirator Use Forms.

SECTION 2

PROJECT DESCRIPTION AND SCOPE OF WORK

2.1 PROJECT DESCRIPTION

Parsons ES and Air Force Center for Environmental Excellence (AFCEE) have developed four contracting options to transition existing and new bioventing pilot systems toward either site closure or expansion into full-scale systems. To complete this task order, Parsons ES will complete remediation monitoring and design and implement full-scale bioventing systems at numerous US Air Force sites. The various tasks that will be performed at these sites is outlined in Section 2.2, Scope of Work.

2.2 SCOPE OF WORK

The objective of the full-scale bioventing program is to extend the operation of existing bioventing pilot systems and to move forward with site closures or design and implementation of full-scale systems. This scope of work was developed through evaluation of previous investigation results, current remediation efforts, and results of a bioventing pilot test at other Air Force sites. This project will include the following four potential options for each site:

Option 1: An additional one year of testing for existing bioventing systems.

Option 2: Closure soil sampling for sites which have demonstrated bioventing success.

Option 3: Complete an initial bioventing test at new sites.

Option 4: Design and installation of a multiple-vent well, full-scale system.

Specific field activities will likely involve the following field tasks as defined by Options 1-4.

Option 1 Repair and replacement of damaged equipment such as blower units, air filters, pressure gauges; general system repairs; respiration testing and collection of soil gas samples.

Option 2 Complete closure soil sampling involving GeoProbe® direct push technology or conventional auger drilling and drill cuttings handling and disposal of investigation derived wastes (IDW).

SECTION 3

PROGRAM TEAM ORGANIZATION

The Parsons ES team assigned to the extended bioventing program, their responsibilities, and lines of authority are outlined below.

Name	Task Assigned
Mr. Ernie Schroeder	Program Manager
Mr. Doug Downey	Technical Director
Mr. John Ratz	Project Manager
Mr. Timothy Mustard	Program Health and Safety Manager
To be assigned	Site Managers
Lt. Maryann Jenner	Contact - AFCEE ERT

The program manager shall be responsible for the overall management of tasks performed under this contract and shall be the primary point-of-contact between AFCEE and Parsons ES. He will be responsible for ensuring that practical and effective systems are developed to meet the specified objectives. The program manager shall also ensure that quality work is accomplished on schedule.

The technical director is responsible for conduct and review of all technical work on this project to ensure technical accuracy and adequacy. He will provide advice to the project manager and project personnel on technical issues.

The project manager is directly responsible for the execution of all phases of this project. He is responsible for planning, staffing, assuring adequate planning for health and safety and quality assurance/quality control (QA/QC), execution of each phase, coordination with AFCEE, and interpretation of data and reporting. The project manager will also coordinate with the site managers to obtain permission for site access, coordination of activities with appropriate officials, and serve as the liaison with public officials.

The program health and safety manager will be responsible for updating and revising the program health and safety plan, as necessary. He will arrange for periodic field audits to ensure that the provisions of the health and safety plan are being enforced.

The site managers will prepare documents for regulatory approval, complete bioventing extended testing and final soil sampling, and construct full-scale systems. In addition, they will assist with day-to-day scheduling, budgeting, and reporting.

SECTION 4

SITE-SPECIFIC EMPLOYEE TRAINING AND MEDICAL MONITORING REQUIREMENTS

The Parsons ES Corporate Health and Safety Manual, incorporated by reference, presents general requirements for Parsons ES employee training and medical monitoring. All field team members will have completed the 40-hour basic health and safety training as specified in 29 CFR 1910.120(e) and the 8-hour annual refresher training thereafter. All supervisory personnel onsite will be required to have completed an 8-hour supervisor course as required in 29 CFR 1910.120(e).

In addition to the 40-hour course, all field employees will be required to have completed a minimum of 3 days onsite training under the supervision of a trained and experienced supervisor. Employees will not participate in field activities until they have been trained to the level required by their job function and responsibility. In addition, at least one person on every Parsons ES crew involved in field activities will have completed Red Cross or equivalent first-aid and cardiopulmonary resuscitation (CPR) courses. All training documentation for Parsons ES personnel will be verified by the SHSO and maintained by the Health and Safety Manager.

All field team members will be on current medical monitoring programs in accordance with federal OSHA requirements (29 CFR 1910.120) and Parsons ES corporate policies. Listed below are additional health and safety training and medical monitoring requirements for this project.

4.1 ADDITIONAL SAFETY TRAINING REQUIREMENTS

Additional training may be required for personnel involved in Level B (SCBA) respiratory protection. This training would be conducted onsite as necessary by a qualified, Level B-experienced supervisor. Employees will also be trained in use, care, maintenance, limitations, and disposal of personal protective equipment in accordance with 29 CFR 1910.132. All field team members must have site-specific training as discussed in the following section.

4.1.1 Site-Specific Safety Briefings

Site-specific safety and health briefings will be conducted by the Parsons ES site manager or site health and safety officer for all personnel who will engage in any extended bioventing activities. Site-specific safety briefings will address the activities, procedures, monitoring, and equipment applicable to the site's operations, as well as

site or facility layout, potential hazards, and emergency response services at the site. Additional topics that will be addressed at the safety briefings will include:

- Names of responsible health and safety personnel;
- Identification of site hazards;
- Site contingencies and emergency procedures;
- Exposure risk;
- Symptoms of exposure and exposure treatment for chemical contaminants;
- Personal protective equipment (PPE) to be used;
- Decontamination procedures to be followed;
- Location of safety equipment;
- Review of planned activities;
- Defined safety procedures to be followed during installation, system repairs and sampling activities; and
- Emergency and evacuation procedures.

Safety briefings will be conducted as needed prior to initiating extended bioventing field activities.

4.2 MEDICAL MONITORING REQUIREMENTS

Prior to being assigned to the field activities, each Parsons ES employee will receive a preassignment or baseline physical examination. Preassignment screening has two major functions: 1) determination of an individual's fitness for duty, including the ability to perform work while wearing PPE; and 2) provision of baseline data for comparison with future medical data. Medical qualification/certification documentation will be maintained by the program health and safety manager. All medical examinations and procedures will be performed by or under the supervision of a licensed physician, preferably an occupational physician. The examination content will be determined by the examining physician in accordance with 29 CFR 1910.120(f).

SECTION 5

SAFETY AND HEALTH RISK ANALYSIS

5.1 CHEMICAL HAZARDS

The chemicals of primary concern occurring at the majority of U.S. Air Force sites are those originating from gasoline, diesel fuel, and jet fuels. Some of these sites may be contaminated with trichloroethene (TCE) or other chlorinated solvents. The properties of gasoline, diesel fuel, and jet fuel and several of its volatile constituents are summarized in Table 5.1. If other compounds are discovered at these sites, the health and safety plan will be amended, and the pertinent information about these compounds will be provided in Table 5.1. The health hazards or other physical/chemical hazards (e.g., corrosiveness, flammability) of the compounds will then be communicated to the onsite employees.

Hazardous substances of primary concern identified at U.S. Air Force sites, are those potentially occurring in contaminated groundwater, soils, sediment, surface water, air, and buildings, or abandoned structures.

5.2 PHYSICAL HAZARDS

In addition to the hazardous substances and conditions potentially present at U.S. Air Force sites, other physical hazards or hazardous conditions may be expected at the site during the course of performing extended bioventing activities. These hazards include possible risks from injury while working around motor vehicles; stationary or moving equipment; fire or explosion hazards; slip, trip, and fall hazards; excavation activities; subsurface investigations; electrical hazards; and excessive noise conditions. Additional physical hazards include heat stress and cold-related exposures. The following subsections further describe these physical hazard concerns.

5.2.1 Motor Vehicles and Heavy Equipment

Large motor vehicles and heavy equipment represent a potential safety hazard at remediation sites. Injuries can result from equipment dislodging, striking unsuspected personnel, and impacts from flying objects or overturning of vehicles. Vehicles and heavy equipment design and operation will be in accordance with 29 CFR, Subpart 0, 1926.600 through 1926.602. In particular, the following precautions will be used to minimize or avoid injuries and accidents:

TABLE 5.1
HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a/] (ppm)	TLV [b/] (ppm)	IDLH [c/] (ppm)	Odor Threshold [d/] (ppm)	Ionization Potential [e/] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f/]	10	3,000	4.7	9.24	Colorless to light–yellow liquid with aromatic odor. Eye, nose and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, and bone marrow depression. Chronic exposure has been linked to leukemia. Carcinogen.
Ethylbenzene	100	100	2,000	0.25–200	8.76	Colorless liquid with an aromatic odor Eye, skin, and mucous membrane irritant. Causes headaches, narcosis, coma.
Gasoline	300	300	NA	0.005–10	NA	Clear/amber flammable, volatile liquid with a characteristic odor. Avoid skin and eye contact. Vapors may result in euphoria, respiratory arrest, and CNS toxicity. Monitor for BTEX constituents.
Jet Fuel	400 [g/]	300 [g/]	10,000 [g/]	0.08–1	NA	Colorless to light brown liquid with a fuel–like odor. Long–term effects include liver, kidney, and CNS damage.
Toluene	100	50 (skin) [h/]	2,000	0.2–40 [i/]	8.82	Colorless liquid with sweet, pungent odor. Causes dizziness, headache, dilated pupils. Targets skin, liver, kidneys, and CNS. Suspected teratogen and mutagen.

TABLE 5.1
HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a] (ppm)	TLV [b] (ppm)	IDLH [c] (ppm)	Odor Threshold [d] (ppm)	Ionization Potential [e] (eV)	Physical Description/Health Effects/Symptoms
Trichloroethene (TCE)	50	50	1,000	21.4–400	9.45	Clear colorless or blue liquid. Ethereal, chloroform–like odor. Skin and eye irritant. Causes headaches, vertigo, visual disturbances, tremors, nausea, vomiting, and cardiac arrhythmia. Carcinogen.
Xylene (o–, m–, p–isomers)	100	100	1,000	0.05–200 [i]	8.5	Colorless liquid with aromatic odor. Causes dizziness, drowsiness, staggered gait, irritation of eyes, nose, skin, and throat, nausea, vomiting, and abdominal pain. Also targets blood, liver, kidneys, and skin.

a/ PEL = Permissible Exposure Limit. OSHA–enforced average air concentration to which a worker may be exposed for an 8–hour workday without harm. PELs published in 29 CFR 1910.1000, 1989. Expressed as parts per million (ppm) unless noted otherwise. Some states (such as California) may have more restrictive PELs. Check state regulations.

b/ TLV = Threshold Limit Value – Time–Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), 1994–1995.

c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health effects. Expressed as ppm unless noted otherwise.

d/ When a range is given, use the highest concentration.

e/ Ionization Potential, measured in electron volts (eV), necessary to determine if field air monitoring equipment can detect substance.

f/ Refer to expanded rules for this compound.

g/ Based on exposure limits for petroleum distillates (naphtha).

h/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.

i/ Olfactory fatigue has been reported for compound and odor may not serve as warning property.

- Mobile equipment brakes, hydraulic lines, light signals, fire extinguishers, fluid levels, steering, tires, horn, and other safety devices will be routinely inspected prior to each work shift.

- Heavy equipment or motor vehicle cabs will be kept free of all nonessential items, and all loose items will be secured.

- Construction and heavy equipment (specifically Geoprobe® operations), will be provided with necessary safety equipment including seat belts, rollover protection, emergency shutoff during rollover, backup warning lights, and audible backup alarms.

Motor vehicles and equipment will be used to perform a portion of the onsite work activities including excavation and backfill, concrete and structural demolition, transportation of earthen materials and debris, and loading of waste materials for transportation offsite. Equipment safety will be addressed during daily tailgate safety meetings, in addition to other operational hazards and concerns that may be anticipated. All field team members and subcontractors assigned to operate heavy equipment will have demonstrated sufficient competence and ability prior to their assignment. Equipment operators and all other field supervisory and support personnel will adhere to following general guidelines:

- Protective clothing and equipment as specified in this HSP and site-specific HSPs will be worn as appropriate to complete the task safely.

- Hand signal communications will be established when verbal or radio communication is difficult or impractical. Only one person will give hand signals to an equipment operator.

- Personnel will never walk directly behind or to the side of operating equipment without the operator's knowledge.

- When operating heavy equipment (such as drilling rigs) near power lines, workers will ensure that the boom or rigging always maintains a safe distance from power lines (20 feet minimum). Any underground utility lines must also be located, and appropriate measures taken before any excavation work or drilling is performed.

- Only qualified operators will be allowed to operate heavy equipment, in accordance with the safe work guidelines included in the OSHA General Industry (29 CFR 1910) and Construction Industry (29 CFR 1926) standards.

- Under no circumstances will any piece of equipment or machinery be modified or used in a manner that may violate the manufacturer's recommended capacity, safety guidelines, or its intended use.

- If any field team members have questions or doubts regarding the safety of any particular activity, he/she will bring it to the attention of his/her supervisor prior to performing the activity.

These guidelines address procedures that are applicable to all types of equipment that may be used during the extended bioventing program at U.S. Air Force Installations Individual equipment types or certain specialized equipment may require additional safety considerations or specialized training prior to its use. Should any specialized equipment be required during the performance of a task, the Program Health and Safety Manager will ensure that operators receive appropriate training. The Program Health and Safety Manager is also responsible for ensuring that all equipment is routinely inspected and that any piece of equipment considered unsafe is not used until the unsafe conditions are corrected or repaired.

5.2.2 Slip, Trip, and Fall Hazards

Remedial activities and existing site conditions may pose a number of slip, trip, and fall hazards, such as:

- Open excavations, pits, or trenches;
- Slippery surfaces;
- Steep or uneven grades;
- Surface obstructions; and
- Construction materials or debris.

All field team members will be instructed to be cognizant of potential safety hazards and immediately inform the SSHO or the site manager about any new hazards. If the hazard cannot be immediately removed, actions must be taken to warn site workers about the hazard. The site will be kept in a neat, organized, and orderly fashion. Rubbish, trash, or debris generated by the project team shall be picked up and properly disposed of on a daily basis. Items such as tools, equipment, and hoses will be properly stored when not in use.

5.2.3 Subsurface Investigations

Before intrusive operations (drilling, soil gas activities, cone penetrometer) are initiated, efforts will be made to determine whether underground installations, (e.g., sewers, telephone, water, fuel, and electric lines) will be encountered and, if so, where such underground installations are located. Site managers will verify that all underground installations have been identified prior to any intrusive operations.

5.2.4 Excavation Activities

Excavation areas in which Parsons ES team members may be expected to enter will be protected as required by adequate shoring or sloping. OSHA excavation, trenching, and shoring standards will be followed as listed in 29 CFR 1926, Subpart P. Excavations may require either structural support, adequate sloping, or a combination of both in order to ensure adequate worker safety. A professional engineer from the Parsons team will design any protective systems (sloping, shoring, or shielding) for

such excavations that are 4 feet or greater in depth and the plans will be maintained and available for inspection onsite.

The following procedures will be strictly adhered to during excavation or trenching activities:

- Prior to initiation of excavation activities all underground utility installations and structures (sewer, water, fuel, electric lines) shall be located and protected from damage or displacement.

- In excavations where oxygen-deficient or hazardous atmospheres may exist, the work area shall be tested prior to worker entry.

- Excavated materials will be placed no closer than 2 feet from the sidewall of the excavation or trench.

- Whenever personnel are required to enter excavations 4 feet deep or greater, access (stairs, ladders, or ramps) shall be used and shall be laterally spaced no greater than 25 feet apart.

- Trenches shall be completely guarded or barricaded on all sides.

- Adequate guards or barricades or flagging shall be placed within 1 to 5 feet from the edge of open excavations. Perimeter protection will be displayed at 3 to 4 feet above ground level. Such barriers shall remain in place until excavation activities are completed and backfilled.

- The walls and spaces of all excavations and trenches greater than 4 feet in depth shall be protected by shoring, sloping of the ground, or equivalent methods.

- Open excavations shall be inspected daily. If there is evidence of sloughing, cave-ins or slides, all work in the excavation shall cease until the necessary safeguards have been implemented.

- All trenches shall be backfilled as soon as practical after work is completed and all associated equipment removed.

- All material and equipment such as pipe and reinforcing steel shall be kept out of traffic lanes and access ways. When not in use, equipment shall be stored out of traffic areas.

5.2.5 Electrical Hazards

Some of the equipment used during field tasks performed at U.S. Air Force sites will be operated by electricity. Maintenance and day-to-day activities require personnel to handle and control this equipment. Unless safe work practices are strictly observed, serious injury or death can result.

Ordinary 120 volt (V) electricity may be fatal. Extensive studies have shown that currents as low as 10 to 15 milliamps (mA) can cause loss of muscle control and that 12 V may, on good contact, cause injury. Therefore, all voltages should be considered dangerous. All electricity should be treated cautiously by trained personnel.

Electricity can paralyze the nervous system and stop muscular action. Frequently, electricity may affect the breathing center at the base of the brain and interrupt the transmission of the nervous impulses to the muscles responsible for breathing. In other cases, the electrical current directly affects the heart, causing it to cease pumping blood. Death follows from lack of oxygen in the body. It cannot be determined which action has taken place; therefore, a victim must be freed from the live conductor promptly by use of a nonconducting implement, such as a piece of wood, or by turning off the electricity to at least this point of contact. Bare hands should never be used to remove a live wire from a victim or a victim from an electrical source. Artificial respiration or CPR should be applied immediately and continuously until breathing is restored, or until a physician or emergency medical technician arrives. General rules for recognizing electrical safety are provided below.

- Only authorized and qualified personnel will perform electrical installations or repairs.
- Rubber mats will be placed in front of electrical panels.
- All electrical wires and circuits will be assumed to be "live," unless absolutely certain they are not.
- Appropriate protective clothing, including rubber gloves and boots, will be worn by personnel performing electrical work.
- Ground fault circuit interrupter receptacles and circuit breakers will be installed where required by the National Electric Code (NFPA 70).
- Electrical control panels will not be opened unless the job requires it.
- No safety device will be made inoperative by removing guards, using oversized fuses, or blocking or bypassing protective devices, unless it is absolutely essential to the repair or maintenance activity, and then only after alerting operating personnel and the maintenance supervisor.
- All power tools will have insulated handles, be electrically grounded, or be double insulated.
- Fuse pullers will be used to change fuses.
- Metal ladders, metal tape measures, or other metal tools will not be used around electrical equipment.
- Wires and extension cords will be placed or arranged so as to not pose a tripping hazard.

5.2.6 Noise-Induced Hearing Loss

Work onsite may involve the use of heavy equipment such as a drill rig, compressor, generator, blower units and excavation equipment. The unprotected exposure of site workers to this noise or to aircraft noise during site activities can result in noise induced hearing loss. Drilling rigs and associated equipment can emit noise levels exceeding the federal OSHA time-weighted average (TWA) limit of 85 decibels (dB). All drill rig and nearby personnel will be required to wear hearing protection necessary to mitigate noise levels to below OSHA TWA. Foam ear plugs will generally provide adequate protection. The SHSO will ensure that either ear muffs or disposable foam earplugs are made available to, and used by, all personnel in the vicinity of the operation of heavy equipment, aircraft noise or other sources of high intensity noise.

5.2.7 Fire or Explosion Hazards

Jet fuel and possibly some solvents have been released into the soils at many of the U.S. Air Force sites. Vapors escaping from the soils may be flammable or explosive (especially if in a confined space). Therefore, precautions should be taken when performing field work (drilling or well construction/installation) to ensure that combustible or explosive vapors have not accumulated, or that an ignition source is not introduced into a flammable atmosphere.

5.2.8 Effects and Prevention of Heat Stress

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. These condition are discussed further below.

If work on this project is conducted in the warm months, or if PPE is used, heat stress may be a concern. Monitoring of personnel wearing PPE will commence when ambient temperature is 70°F or above. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. They can range from mild symptoms such as fatigue; irritability; anxiety; and decreased concentration, dexterity, or movement; to death. Medical help must be obtained for the more serious cases of heat stress. One or more of the following actions will help reduce heat stress:

- Provide plenty of liquids. To replace body fluids (water and electrolytes) lost due to perspiration, use a 0.1 percent salt water solution, heavily salted foods, or commercial mixes. The commercial mixes may be preferable for those employees on a low-sodium diet.

- Provide cooling devices (such as water jackets or ice vests) to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker efficiency.

- Wear long cotton underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.

- Install portable emergency showers and/or hose-down facilities to reduce body temperature and to cool protective clothing.

- In extremely hot weather, conduct non-emergency response operations in the early morning or evening.

- Ensure that adequate shelter is available to protect personnel against sun, heat, or other adverse weather conditions which decrease physical efficiency and increase the probability of accidents.

- In hot weather, rotate workers wearing protective clothing.

- Maintain good hygienic standards, frequently changing clothing and showering daily. Clothing should be permitted to dry during rest periods. Workers who notice skin problems should immediately consult the SSHO.

5.2.8.1 Heat-Related Problems

- Heat rash: Caused by continuous exposure to heat and humid air, and aggravated by chafing clothes. Decreases ability to tolerate heat and is a nuisance.

- Heat cramps: Caused by profuse perspiration with inadequate fluid intake and chemical replacement, especially salts. Signs include muscle spasm and pain in the extremities and abdomen.

- Heat exhaustion: Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shortness of breath; increased pulse rate (120-200 beats per minute); pale, cool, moist skin; profuse sweating; and dizziness and lassitude.

- Heat stroke: The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and possibly coma. Medical help must be obtained immediately.

5.2.8.2 Heat-Stress Monitoring

Monitoring of personnel wearing impermeable clothing will begin when the ambient temperature is 70°F (21°C) or above. Table 5.2 presents the suggested frequency for such monitoring. Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed. Heat-stress monitoring will be performed by a person with current first-aid certification who is trained to recognize heat-stress symptoms. For monitoring the body's recuperative capabilities in response to excess heat, one or more of the techniques listed below will be used. Other methods of heat-stress monitoring, such as the wet-bulb globe temperature index from the American Conference of Governmental Industrial Hygienists (ACGIH) (1992) Threshold Limit Value (TLV) Booklet may be used.

TABLE 5.2

SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS[a]

Adjusted Temperature[b]	Normal Work Ensemble[c]	Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F (30.8°-32.2° C)	After each 60 minutes of work	After each 30 minutes of work
82.5° -87.5° F (28.1°--30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5°-82.5° F (25.3°-28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5°-77.5°F (22.5° -25.3°C)	After each 150 minutes of work	After each 120 minutes of work

a For work levels of 250 kilocalories/per hour.

b Calculate the adjusted air temperature (ta adj) by using this equation: ta adj = ta °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent of time the sun is not covered by clouds that are thick enough to produce a shadow (100 percent sunshine - no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows).

c A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and trousers.

d Saranex®, Poly-Coated Tyvek®, Etc.

To monitor the worker, measure:

- Heart rate: Count the radial pulse during a 30-second period as early as possible during the rest period.
  - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will remain the same.
  - If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be reduced by one-third.
- Oral temperature: Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
  - If oral temperature exceeds 99.6° (37.6°C), the next work cycle will be reduced by one-third without changing the rest period.
  - If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, the following work cycle will be reduced by one-third.
  - No worker will be permitted to wear a semipermeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

5.2.9 Cold Exposure

It is possible that work on this project may be conducted during the winter months; therefore, injury due to cold exposure may become a problem for field personnel. Cold exposure symptoms, including hypothermia and frostbite, will be monitored when personnel are exposed to low temperatures for extended periods of time.

Persons working outdoors in temperatures at or below freezing may suffer from cold exposure. During prolonged outdoor periods with inadequate clothing; effects of cold exposure may even occur at temperatures well above freezing. Cold exposure may cause severe injury by freezing exposed body surfaces (frostbite), or may result in profound generalized cooling (hypothermia), possibly causing death. Areas of the body which have high surface area-to-volume ratios such as fingers, toes, and ears are the most susceptible to frostbite.

Two factors influence the development of a cold injury: ambient temperature and wind velocity. Wind chill is used to describe the chilling effect of moving air in combination with low temperature. For example, 14°F with a wind speed of 15 miles per hour (mph) is equivalent in chilling effect to still air at -18°F. Cold exposure is particularly a threat to the hazardous waste site worker if the body cools suddenly when chemical-protective equipment is removed and the clothing underneath is perspiration-soaked. The presence of wind greatly increases the rate of cooling.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- Frost nip or incipient frostbite: characterized by suddenly blanching or whitening of skin.

- Superficial frostbite: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.

- Deep frostbite: tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia, or lowering of the core body temperature, is caused by exposure to freezing or rapidly dropping temperatures. Symptoms are usually exhibited in five stages:

- Shivering and uncoordination;
- Apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F (35°C);
- Unconsciousness, glassy stare, slow pulse, and slow respiratory rate;
- Freezing of the extremities; and
- Death.

5.2.9.1 Evaluation and Control

TLVs recommended for properly clothed workers for periods of work at temperatures below freezing are shown in Table 5.3. For exposed skin, continuous exposure should not be permitted when the air speed and temperature results in an equivalent chill temperature of -32°C (-25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below -1°C (30.3°F) regardless of wind speed.

Special protection of the hands is required to maintain manual dexterity for the prevention of accidents. If fine work is to be performed with bare hands for more than 10 to 20 minutes in an environment below 16°C (60.8°F), special provisions should be established for keeping the workers' hands warm. For this purpose, warm air jets, radiant heaters (fuel burner or electric radiator), or contact warm plates may be used. At temperatures below -1°C (30.2°F), metal handles of tools and control bars should be covered by thermal insulating material.

To prevent contact frostbite, workers should wear gloves. When cold surfaces below -7°C (19.4°F) are within reach, a warning will be given to the workers by the supervisor or SSHO to prevent inadvertent contact with bare skin. If the air temperature is -17.5°C (0°F) or less, the hands should be protected by mittens. Machine controls and tools for use in cold conditions should be designed so that they can be handled without removing the mittens.

Provisions for additional total body protection are required if work is performed in an environment at or below 4°C (39.2°F). The workers will wear cold protective

TABLE 5.3

Threshold Limit Values Work/Warm-up Schedule for Four-Hour Shift

Air Temperature - Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. Breaks)	1	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4
-29° to -31°	-20° to -24°	(Norm. Breaks)	1	75 min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease		↓	
-38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease		↓		↓	
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease		↓		↓		↓	
-43° & below	-45° & below	Non-emergency work should cease		↓		↓		↓		↓	

Notes for Table 5.3

1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For light-to-moderate work (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4 hour period (Step 5).

2. The following is suggested as a guide for estimating wind velocity if accurate information is not available: 5 mph; light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.

3. In general the warm-up schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges, since windy conditions rarely prevail at extremely low temperatures.

4. TLVs apply only for workers in dry clothing.

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clothing appropriate for the level of cold and physical activity. If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind should be reduced by shielding the work area or by wearing an easily removable windbreak garment. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work will be modified or suspended until adequate clothing is made available or until weather conditions improve.

5.2.9.2 Work-Warming Regimen

If work is performed continuously in the cold at an equivalent chill temperature (ECT) below -7°C (19.4°F), heated warming shelters (tents, cabins, rest rooms) will be made available nearby. The workers will be encouraged to use these shelters at regular intervals, the frequency depending on the severity of the environmental exposure. The onset of heavy shivering, frostnip, the feeling of excessive fatigue, drowsiness, irritability, or euphoria are indications for immediate return to the shelter. When entering the heated shelter, the outer layer of clothing should be removed and the remainder of the clothing loosened to permit sweat evaporation or a change of dry work clothing provided. A change of dry work clothing may be necessary to prevent workers from returning to work with wet clothing. Dehydration, or the loss of body fluids, occurs insidiously in the cold environment and may increase the susceptibility of the worker to cold injury due to a significant change in blood flow to the extremities. Warm sweet drinks and soups should be provided at the work site to provide caloric intake and fluid volume. The intake of coffee should be limited because of the diuretic and circulatory effects.

For work practices at or below -12°C (10.4°F) ECT, the following should apply:

- The workers will be under constant protective observation (buddy system or supervision).
- The work rate should not be so high as to cause heavy sweating that will result in wet clothing; if heavy work must be done, rest periods will be taken in unheated shelters and opportunity for changing into dry clothing should be provided.
- New employees should not be required to work full-time in the cold during the first days of employment until they become accustomed to the working conditions and required protective clothing.
- The weight and bulkiness of clothing should be included in estimating the required work performances and weights to be lifted by the worker.
- The work should be arranged in such a way that sitting still or standing still for long periods is minimized. Unprotected metal chair seats will not be used. The worker should be protected from drafts to the greatest extent possible.
- The workers will be instructed in safety and health procedures relative to cold exposures.

5.3 BIOLOGICAL HAZARDS

Various biological hazards may be encountered at many of the U.S. Air Force Installations. These include pathogenic organisms/diseases such as Hantavirus, Bubonic Plague, Equine Encephalitis, Rocky Mountain Spotted Fever, and Lyme Disease. Other biological hazards include insects, snakes, spiders, and cactus.

Hantavirus has been reported from the "Four Corners" area of the southwestern U.S. The Four Corners strain of Hantavirus has had a 60 percent mortality rate. Deer mice are the primary reservoir for the virus. The virus is excreted in mouse feces, urine, and saliva. Humans may become infected if the virus is inhaled or absorbed through breaks in the skin, by ingesting contaminated food or water, or by being bitten by an infected rodent.

The incubation period for Hantavirus may be three days to six weeks. Symptoms include fever, chills, headache, dizziness, muscle aches, dry cough, nausea, vomiting, abdominal cramps, diarrhea, and shortness of breath. Progression of the disease leads to fluid in the lungs, heart irregularities, and kidney failure. Personnel will use high efficiency particulate air (HEPA) filter-equipped air-purifying respirators when working in rodent-infested areas or when entering sheds of buildings containing mice infestations.

Bubonic plague is a bacterial disease which is spread to humans by fleas that have bitten an infected animal.

Bubonic plague displays symptoms rapidly. Chills and fever are soon accompanied by swelling of the lymph nodes, usually on one side of the body. These painful swellings are usually dark blue to black, hence the other popular name for this disease, "black death." The disease is treatable with antibiotics.

Field personnel will wear Tyvek® suits with leg seams taped to boots or boot covers in prairie dog towns to minimize contact with fleas.

Equine encephalitis, an inflammation of the brain, can be carried by mosquitoes. Field personnel must wear long-sleeved clothing and/or use insect repellents if they are working in areas of mosquito infestations.

Bites from wood ticks may result in the transmission of Rocky Mountain Spotted Fever - a serious and often fatal viral disease. The Rickettsia virus infects wood ticks, which can bite humans and transfer the virus into the bloodstream. Rocky Mountain Spotted Fever occurs mostly in the late spring and early summer, and is characterized by a red rash around a tick bite, chills, fever, severe pain in leg muscles and joints, and a body rash. Lyme Disease exhibits similar symptoms. Prompt medical treatment with antibiotics is usually successful in preventing further complications from these diseases. Personal protective equipment will offer some protection, but the use of insect repellent may also be warranted. Personnel should perform self-searches after each day to check for ticks.

The potential for contact with snakes or insects which may cause injury or disease exists when performing bioventing activities at U.S. Air Force Installations. There are plants which may be injurious (i.e., thorns) as well. Sturdy work clothes and shoes will be worn by field personnel to help prevent injuries. Personnel should be aware that rattlesnakes may be present in the area and should exercise caution, especially when working in previously undisturbed areas and locations around animal dens.

Poison ivy, poison oak, and poison sumac can be encountered at many Air Force Installations. Poison ivy is a woody vine leaves are divided into three leaflets. Poison oak is a low branching shrub with leaflets also in threes. Poison sumac is a shrub or small tree occurring in swamps. Poison sumac have 7 to 13 leaflets which resemble those of green ash trees. All of these species are poisonous and can cause contact dermatitis. Personnel must wear Tyveck® suits or other protective clothing when working in areas containing these plant species.

Black widow spiders and scorpions may be present onsite. The black widow spider has a shiny black body about the size of a pea, with a red or yellow hourglass-shaped mark on its abdomen. It weaves shapeless diffuse webs in undisturbed areas. A bite may result in severe pain, illness, and possible death from complications, but usually not from the bite itself. There are several types of scorpions native to the United States. Scorpions may be brown to yellowish in color, and range from 1/2 inch to 8 inches in length. Their bodies are divided into two parts - a short thick upper body, and a long abdomen with a six-segmented tail. A scorpion has six pairs of jointed appendages - one pair of small pincers, one pair of large claws, and four pairs of jointed legs. They are most active at night. A scorpion sting is very painful, but usually will not result in death.

In addition to spiders and scorpions, bees and wasps may be nuisances to field personnel. Properly trained personnel will administer first aid should a bee or wasp sting occur.

5.4 HAZARD EVALUATION

Within the U.S. Air Force sites and their respective surroundings, personnel conducting field activities may be potentially exposed to certain groups of chemical toxicants by both the respiratory and skin absorption routes. The risk of exposure and the severity of the resultant physiologic reaction to any of the contaminants previously identified are determined chiefly by inherent toxicity, concentration, physical characteristics, duration of exposure, and individual work susceptibility or hypersensitivity.

Complete descriptions of the known chemical compounds that may be encountered during onsite investigations are listed in Table 5.1. Most of the contaminants listed in Table 5.1 were identified based on historical uses of the particular Air Force site and on results of previous Parsons ES bioventing pilot studies.

During site activities, all personnel must assume that disturbance of various physical media (e.g., soil, sediments, purged groundwater) could potentially result in worker exposures to any of the contaminants identified in Table 5.1. Therefore, appropriate

levels of respiratory protection and PPE will be required during remediation of contaminated air, liquids, and solids within Air Force sites to ensure worker safety. Levels of respiratory protection and the required clothing for each level are further defined in Section 7 of this Health and Safety Plan.

SECTION 6

EMERGENCY RESPONSE PLAN

All hazardous waste site activities will present a degree of risk to onsite personnel. During routine operations, risk is minimized by establishing good work practices, staying alert, and using proper personal protective equipment (PPE). Unpredictable events such as physical injury, chemical exposure, or fire may occur and must be anticipated. All field team members must participate in Red Cross or equivalent first aid and cardiopulmonary resuscitation (CPR) courses to more effectively handle physical and medical emergencies that may arise in the field. The sections below establish procedures and guidelines for emergencies.

6.1 GUIDELINES FOR PRE-EMERGENCY PLANNING AND TRAINING

Employees must read this health and safety plan, the site specific addendum to this plan, and familiarize themselves with the information in this chapter. Prior to project initiation, the SHSO will conduct a meeting with the field team members to review the provisions of this health and safety plan and to review the emergency response plan. Employees are required to have a copy of the emergency contacts and telephone numbers immediately accessible onsite and know the route to the nearest emergency medical services. The emergency contacts, telephone numbers, and routes to the hospital will be provided in the site-specific health and safety plan addenda prepared for each bioventing site.

6.2 EMERGENCY RECOGNITION AND PREVENTION

Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while onsite.
- A condition is discovered that suggests the existence of a situation more hazardous than anticipated. (e.g. flammable atmospheres, drums encountered)
- Concentrations of combustible vapors reach or exceed 20 percent of the lower explosive limit (LEL).
- A fire or explosion hazard exists.
- Concentrations of organic vapors exceed 1.0 ppm above background air concentrations (based on the PEL for benzene) on a PID.

- A vehicle accident occurs.

Some ways of preventing emergency situations are listed below.

- Site workers must maintain visual contact and should remain close together to assist each other during emergencies. (Use the buddy system.)

- During continual operations, onsite workers act as safety backup to each other. Offsite personnel provide emergency assistance.

- All field crew members should make use of all of their senses to alert themselves to potentially dangerous situations which they should avoid (e.g., presence of strong and irritating or nauseating odors).

- Field crew members will be familiar with the physical characteristics of investigations, including:

  - Wind direction in relation to contamination zones;
  - Accessibility to associates, equipment, and vehicles;
  - Communications;
  - Hot zone (areas of known or suspected contamination) this must be marked off;
  - Site access; and
  - Nearest water sources.

- Personnel and equipment in a work area should be minimized, consistent with effective site operations.

In the event that any member of the field crew experiences any adverse effects or symptoms of exposure while on the scene, or that organic vapors and combustible vapors exceed the action limits (see the site specific addenda), the entire field crew will immediately halt work and act according to the instructions provided by the SHSO.

The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated will result in the evacuation of the field team and reevaluation of the hazard and the level of protection required.

In the event an accident occurs, the site manager is to complete an Accident Report Form. Follow-up action should be taken to correct the situation that caused the accident.

6.3 PERSONNEL ROLES, LINES OF AUTHORITY, AND COMMUNICATION PROCEDURES DURING EMERGENCY

When an emergency occurs, decisive action is required. Rapidly made choices may have far-reaching, long-term consequences. Delays of minutes can create or exacerbate

life-threatening situations. Personnel must be ready to respond to emergency situations immediately. All personnel will know their own responsibilities during an emergency, know who is in charge during an emergency, and the extent of that person's authority. This section outlines personnel roles, lines of authority, and communication procedures during emergencies.

In the event of an emergency situation at the site, the field team leader will assume total control and will be responsible for onsite decision making. The designated alternate for the field team leader will be the site health and safety officer. These individuals have the authority to resolve all disputes about health and safety requirements and precautions. They will also be responsible for coordinating all activities until emergency response teams (ambulance, fire department, etc.) arrive onsite.

The site manager and/or site health and safety officer will ensure that the necessary US Air Force installation personnel, Parsons ES personnel, and agencies are contacted as soon as possible after the emergency occurs. All onsite personnel must know the location of the nearest phone and the location of the emergency phone number list.

6.4 EVACUATION ROUTES AND PROCEDURES, SAFE DISTANCES, AND PLACES OF REFUGE

In the event of emergency conditions, decontaminated employees will evacuate the area as instructed, transport decontaminated injured personnel, or take other measures to ameliorate the situation. Evacuation routes and safe distances will be decided upon and posted by the field team prior to initiating work.

6.5 DECONTAMINATION OF PERSONNEL DURING AN EMERGENCY

Procedures for leaving a contaminated area must be planned and implemented prior to going onsite. Work areas and decontamination procedures will be established based on anticipated site conditions. If a member of the field crew is exposed to chemicals, the emergency procedures outlined below will be followed:

- Another team member (buddy) will assist or remove the individual from the immediate area of contamination to an upwind location.
- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing will be removed if it is safe to do so.
- Administer first aid and transport the victim to the nearest medical facility, if necessary.

If uninjured employees are required to evacuate a contaminated area in an emergency situation, emergency decontamination procedures will be followed. At a minimum these would involve moving into a safe area and removing protective equipment. Care will be taken to minimize contamination of the safe area and personnel. Contaminated clothing will be placed in plastic garbage bags or other suitable containers. Employees will wash or shower as soon as possible.

6.6 EMERGENCY SITE SECURITY AND CONTROL

For this project, the field team leader (or designated representative) must know who is on site and who is in the work area. Personnel access into the work area will be controlled. In an emergency situation, only necessary rescue and response personnel will be allowed into the exclusion zone.

6.7 PROCEDURES FOR EMERGENCY MEDICAL TREATMENT AND FIRST AID

6.7.1 Chemical Exposure

In the event of chemical exposure (skin contact, inhalation, ingestion) the following procedures will be implemented:

- Another team member (buddy) will assist or remove the individual from the immediate area of contamination to an upwind location.
- Precautions will be taken to avoid exposure of other individuals to the chemical.
- If the chemical is on the individual's clothing, the clothing will be removed if it is safe to do so.
- If the chemical has contacted the skin, the skin will be washed with copious amounts of water, preferably under a shower.
- In case of eye contact, an emergency eye wash will be used. Eyes will be washed for at least 15 minutes. Emergency eyewashes will comply with ANSI Z-358.1 and filled with tempered water maintained no cooler than 60°F and no warmer than 95°F. Eyewashes will be capable of delivering 0.4 to 0.8 gallons of water to both eyes for a minimum of 15 minutes. Each jobsite will have at least one emergency eyewash station. Each crew will have, at a minimum, an ANSI-approved personal eyewash suitable for initial eye flushing while the injured person is moved to an emergency eyewash station or medical facility.
- If necessary, the victim will be transported to the nearest hospital or medical center. If necessary, an ambulance will be called to transport the victim.

6.7.2 Personal Injury

In the event of personal injury:

- Field team members trained in first aid can administer treatment to an injured worker.
- The victim will be transported to the nearest hospital or medical center. If necessary, an ambulance will be called to transport the victim.
- The field supervisor is responsible for the completion of the appropriate accident report form.

6.7.3 Fire or Explosion

In the event of fire or explosion, personnel will evacuate the area immediately. Administer necessary first aid to injured employees. Personnel will proceed to a safe area and telephone the emergency support services. Upon contacting the emergency support services, state your name, nature of the hazard (fire, high combustible vapor levels), the location of the incident, and whether there were any physical injuries requiring an ambulance. Do not hang up until the emergency support services has all of the additional information they may require.

SECTION 7

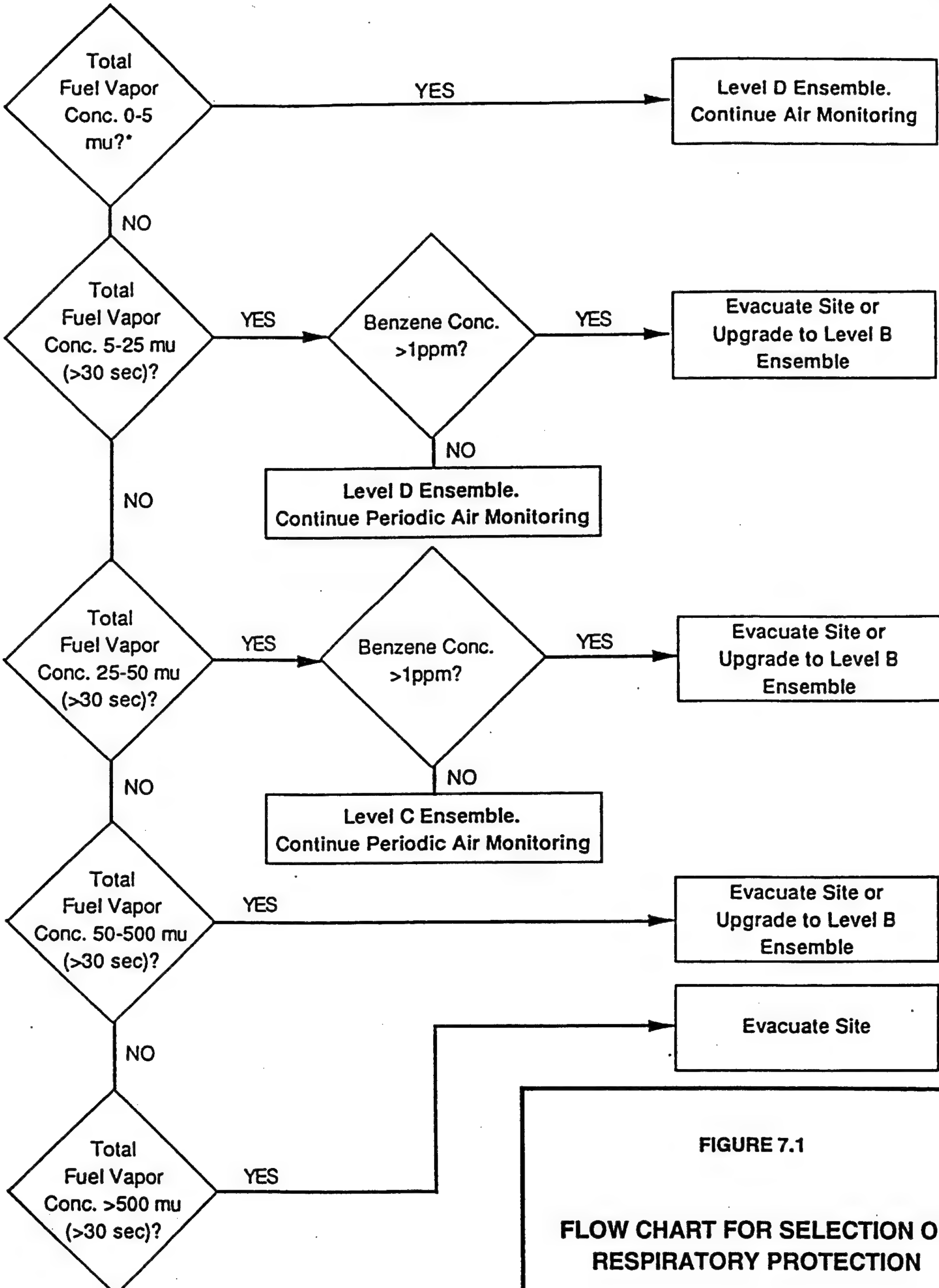
LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

7.1 PERSONAL PROTECTIVE EQUIPMENT

The personal protection level prescribed for the extended bioventing program at U.S. Air Force Installations OSHA Level D with a contingency for the use of OSHA Level C or B as site conditions require. Unless certain compounds are ruled out through use of appropriate air monitoring techniques such as Dräger® tubes, or table sampling pumps, or an onsite gas chromatograph (GC), Level C respiratory protection [air purifying respirator (APR)] cannot be used. Level C protection may only be used on this project when vapors in air are adequately identified and quantified and Level C respirator-use criteria are met. Personal protective equipment (PPE) will be required when handling contaminated samples, working with potentially contaminated materials, during construction or installation of bioventing systems. Figure 7.1 provides direction for selection of respiratory protection. The SHSO must ensure that all field personnel are properly trained in use, maintenance, limitations (including breakthrough time), and disposal of PPE assigned to them in accordance with federal OSHA regulations in 29 CFR 1910.132. Disposable PPE will be used whenever possible to simplify decontamination, to reduce generation of contaminated washwater, and to avoid potential problems with chemical permeation (breakthrough). Single-use PPE (such as Tyvek® will be disposed of whenever personnel go through decontamination. At most, a single item of disposable PPE (including respirator cartridges) will be used for no more than one day and then will be disposed of. Double layers of gloves will be used when personnel are handling contaminated soil or water, or equipment to minimize breakthrough. If personnel note chemical odors on their hands, clothing, or skin after wearing PPE, or develop skin irritation or rashes, consult with the SHSO and decide on alternate actions and/or seek medical attention.

Ambient air monitoring of organic vapors will be performed using photoionization detectors such as an HNu® or Photovac MicroTIP® or colorimetric analysis with Dräger® tubes. Employee exposure monitoring for particulates will be conducted if necessary using portable air sampling pumps. The direct-reading instrumentation will be used to select the appropriate level of personal protection. The criteria to be used for respiration selection are shown in Figure 7.1.

If organic vapor concentrations onsite are in the range of 1 ppm above background, the field team must evacuate the area or use Dräger® tubes or equivalent instruments to identify whether benzene is present. If concentrations of benzene exceed 1 ppm in the breathing zone, the field team must evacuate the area until benzene concentrations drop below the PEL or until Level B respiratory protection can be provided.



* mu = Meter Units

FIGURE 7.1

FLOW CHART FOR SELECTION OF RESPIRATORY PROTECTION

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

Extended bioventing site activities at U.S. Air Force Installations will include soil and soil gas sampling, monitoring well installation, and surface and ground water sampling. The required personal protective ensemble for each activity is presented below:

Drilling and Sampling of Soil Borings/Ground Water Well Installation

Mandatory Equipment:
- Leather boots, steel toe and shank
- Hard hats
- Safety glasses
- Vinyl or Latex inner gloves
- Butyl outer gloves/Nitrile Inners
- Ear plugs

Optional Equipment:
- Tyvek® suits
- Saranex® suits or rainsuits
- Outer boot covers
- Respirators equipped with organic/HEPA cartridges

*Vinyl or latex inner gloves must be worn when handling split-spoon samples. If preliminary sample analysis with a photoionization detector indicates potential contamination, butyl gloves will also be worn. Outer boot covers, Saranex® suits, or rainsuits should be worn when potential for liquid contamination exists.

Ground Water Sampling

*Mandatory Equipment:
- Vinyl or latex inner gloves
- Butyl outer gloves

Optional Equipment:
Respirators equipped with:
- Organic vapor/HEPA cartridges
- Saranex® suits or rainsuits
- Chemical goggles
- Rubber safety boots

*At potentially contaminated wells. If there is a potential for contact with contaminated ground water, use rainsuits and gloves, as appropriate.

7.2 EQUIPMENT NEEDS

Each field team will have the following items readily available:

- Copy of program health and safety plan and site-specific addendum and a separate list of emergency contacts;
- First aid kit which includes PPE for bloodborne pathogens;
- Eyewash bottle;

- Paper towels;
- Duct tape;
- Water (for drinking and washing);
- Plastic garbage bags;
- Fire extinguisher; and
- Earplugs.

7.3 EQUIPMENT DISPOSAL

All reusable PPE (such as hardhats and respirators), if contaminated, will be decontaminated in accordance with procedures specified in Section 10 of this health and safety plan. Contaminated single-use PPE (such as Tyvek® suits and protective gloves) will be properly disposed of in drums. The drums will be labeled with the type of material, site number and location, boring/monitoring well identification, date, U.S. Air Force project manger and his/her telephone number.

SECTION 8

FREQUENCY AND TYPES OF AIR MONITORING

Air monitoring will be used to identify and quantify airborne levels of hazardous substances. Periodic monitoring is required during on site activities. The types of monitoring and equipment to be used are as follows:

Type of Equipment	Minimum Calibration Frequency	Parameter(s) to be Measured	Minimum Sampling Frequency	Sampling Locations
Photoionization Detector	1/day	Organic Vapors	• 4/hr or each 5-foot intervals (while disturbing or drilling into soils) • 1/hour when working near soil vapor extraction unit	• Breathing Zone • Soil Borings • Monitoring Wells • Resiration Testing
Sensidyne® or Draeger® Tubes	None (check manufacturer's requirements)	Benzene	• When PID exceeds 1 ppm	• Breathing Zone • Soil Borings • Monitoring Wells
Dosimeter Badges	None	Benzene	• As needed on workers with greatest exposure to contamination	• Breathing Zone

During intrusive operations that disturb site soils, a photoionization detector (such as an HNu®, Photovac TIP®, or MicroTIP®) should be used to measure ambient air concentrations in the worker breathing zone. A concentration of 1 ppm above background in the breathing zone will necessitate evacuation until the area is well ventilated (based on the exposure limit for benzene). If benzene is ruled out then proceed to sample for compounds with the next highest PEL/TLV (action level).

Worker exposure monitoring will be conducted to document any exposures of Parsons ES personnel to organic vapors received on site. Portable air sampling pumps or organic vapor monitoring badges will be used for personal exposure monitoring, if necessary.

The following general protocols will be followed for monitoring with pumps.

- The portable pump will be calibrated to the required flow rate (liters per minute) following specific manufacturer's calibration procedures;
- The pump will be equipped with the appropriate sorbent tube for the particular organic compounds to be monitored (such as charcoal for volatile organics);
- An air monitoring data sheet will be completed which will list pump flow rates, start and stop times, sorbent tube used, etc.;
- The pump will undergo a final flow rate check;
- The laboratory analysis results will be disclosed to the employee(s) monitored; and
- The analysis results will be placed in the employee's permanent medical file for documentation of any exposures received.

An organic vapor monitoring badge will be attached in the worker's breathing zone for an eight hour period, three times over the course of the project and while free product is being sampled. A blank will also be sent with the badges for analysis. These personal dosimeter badges work by means of diffusion so that no pump, calibration or batteries are necessary.

SECTION 9

SITE CONTROL MEASURES

The following site control measures will be followed in order to minimize potential contamination of workers, protect the public from potential site hazards, and to control access to the sites. Site control involves the physical arrangement and control of the operation zones and the methods for removing contaminants from workers and equipment. The first aspect, site organization, is discussed in this section. The second aspect, decontamination, is considered in the next section.

9.1 SITE ORGANIZATION/OPERATION ZONES

Any time respirators are worn, the following operation zones will be established on the site or around a particular site feature (such as the drill rig, or bioventing system).

- Exclusion Zone (Contamination Zone),
- Contamination Reduction Zone, and
- Support Zone.

If protective clothing, such as gloves and/or Tyvek, suits are worn but respirators are not worn (Level D-modified), the field crew will establish a decontamination area to avoid spreading contaminants offsite. The field team leader and/or SHSO will be responsible for establishing the size and distance between zones at the site or around the site feature. Considerable judgment is required to assure safe working distances for each zone are balanced against practical work considerations.

9.1.1 Exclusion Zone (EZ) (Contamination Zone)

The EZ includes the areas where active investigation or cleanup operations take place. Within the EZ, prescribed levels of PPE must be worn by all personnel. The hotline, or EZ boundary, is initially established based upon the presence of actual wastes or apparent spilled material, or through air monitoring, and is placed around all physical indicators of hazardous substances. The hotline may be readjusted based upon subsequent observations and measurements. This boundary should be physically secured and posted or well-defined by physical and geographic boundaries.

Under some circumstances, the EZ may be subdivided into zones based upon environmental measurements or expected onsite work conditions.

9.1.2 Contamination Reduction Zone (CRZ)

Between the EZ and the support zone is the CRZ. This zone provides an area to prevent or reduce the transfer of hazardous materials which may have been picked up by personnel or equipment leaving the exclusion area. All decontamination activities occur in this area. The organization of the CRZ, and the control or decontamination operations, are described in Section 10.

9.1.3 Support Zone

The support zone is the outermost area of the site and is considered a noncontaminated or clean area. The support zone contains the command post for field operations, first aid stations, and other investigation and cleanup support. Normal work clothes are appropriate apparel within this zone; potentially contaminated personnel clothing, equipment, etc., are not permitted.

9.2 SITE SECURITY

Site security is necessary to prevent exposure of unauthorized, unprotected individuals in the work area. The areas immediately surrounding the work area will be clearly marked through use of warning signs, traffic cones, barrier tape, rope, or other suitable means.

Site security will be enforced by the SHSO who will ensure that only authorized personnel are allowed in the work area and that entry personnel have the required level of PPE, are trained under the requirements of 29 CFR 1910.120, and are on a current medical monitoring program.

9.3 SITE COMMUNICATION

Internal site communication is necessary to alert field team members in the EZ and CRZ of emergency conditions, to convey safety information, and to communicate changes or clarification in the work to be performed. For internal site communication, the field team members will use prearranged hand signals (and responses). Radios and/or compressed air horns may also be used for communication.

External site communication is necessary to coordinate emergency response teams and to maintain contact with essential offsite personnel. A telephone will be available for use in external site communication. A list of emergency contact phone numbers will be provided in subsequent addenda.

9.4 SAFE WORK PRACTICES

To ensure a strong safety awareness program during field operations, personnel will have adequate training, this health and safety plan must be communicated to the employees, and standing work orders developed and communicated to the employees. Sample standing orders for personnel entering the CRZ and EZ are as follows:

- No smoking, eating, drinking;

- No matches/lighters in the zone;
- Check in/check out at access control points;
- Use the buddy system;
- Wear appropriate PPE;
- Avoid walking through puddles or stained soil;
- Discovery of unusual or unexpected conditions will result in immediate evaluation and reassessment of site conditions and health and safety practices;
- Conduct safety briefings prior to onsite work;
- Conduct daily/weekly safety meetings as necessary; and
- Take precautions to reduce injuries from heavy equipment and other tools.

The following guidelines will also be followed while working onsite:

- Heavy Equipment - Only qualified operators will be allowed to operate heavy equipment. Subcontractors will be required to use the safe work guidelines included in the OSHA General Industry (29 CFR 1910) and Construction Industry (29 CFR 1926) Standards.
- Electrical Equipment - As outlined in Section 5.2.5.
- Machine Guarding - All machinery onsite will be properly guarded to prevent contact with rotating shafts, blades or gears.
- Illumination - Work areas will be lighted beyond the minimum requirements of 29 CFR 1910.120
- Engineering Controls - In the event that the project requires additional provisions to safeguard the public and onsite personnel.

SECTION 10

DECONTAMINATION PROCEDURES

10.1 PERSONNEL DECONTAMINATION PROCEDURES

An EZ, CRZ, and support zone will be established whenever field personnel are using Level C respiratory protection. Decontamination station layout will be made on a site-specific basis and will be designed to accommodate the particular PPE worn by employees and the types of chemical hazards encountered. Defined site access and egress points will be established and personnel will enter and exit only through these points. As a general rule, persons assisting in the decontamination station may be in one level lower of respiratory protection than required in the work zone.

A guideline for personnel decontamination is presented in Figure 10.1. This procedure may be modified by the SSH if necessary.

If personnel are in Level D-modified protection (no respirator but using protective gloves and/or suits and other equipment), a portable decontamination station will be set up at the site. The decontamination station will include provisions for collecting disposable PPE (e.g., garbage bags); washing boots, gloves, vinyl rain suits (if used), and field instruments and tools; and washing hands, face, and other exposed body parts. Onsite personnel will shower upon return to their hotel or homes at the end of the work day. Refuse from decontamination will be bagged and left onsite for proper disposal.

Decontamination equipment will include:

- Plastic buckets and pails;
- Scrub brushes and long-handle brushes;
- Detergent;
- Containers of water;
- Paper towels;
- Plastic garbage bags;
- Plastic or steel 55-gallon barrels;
- Distilled water; and

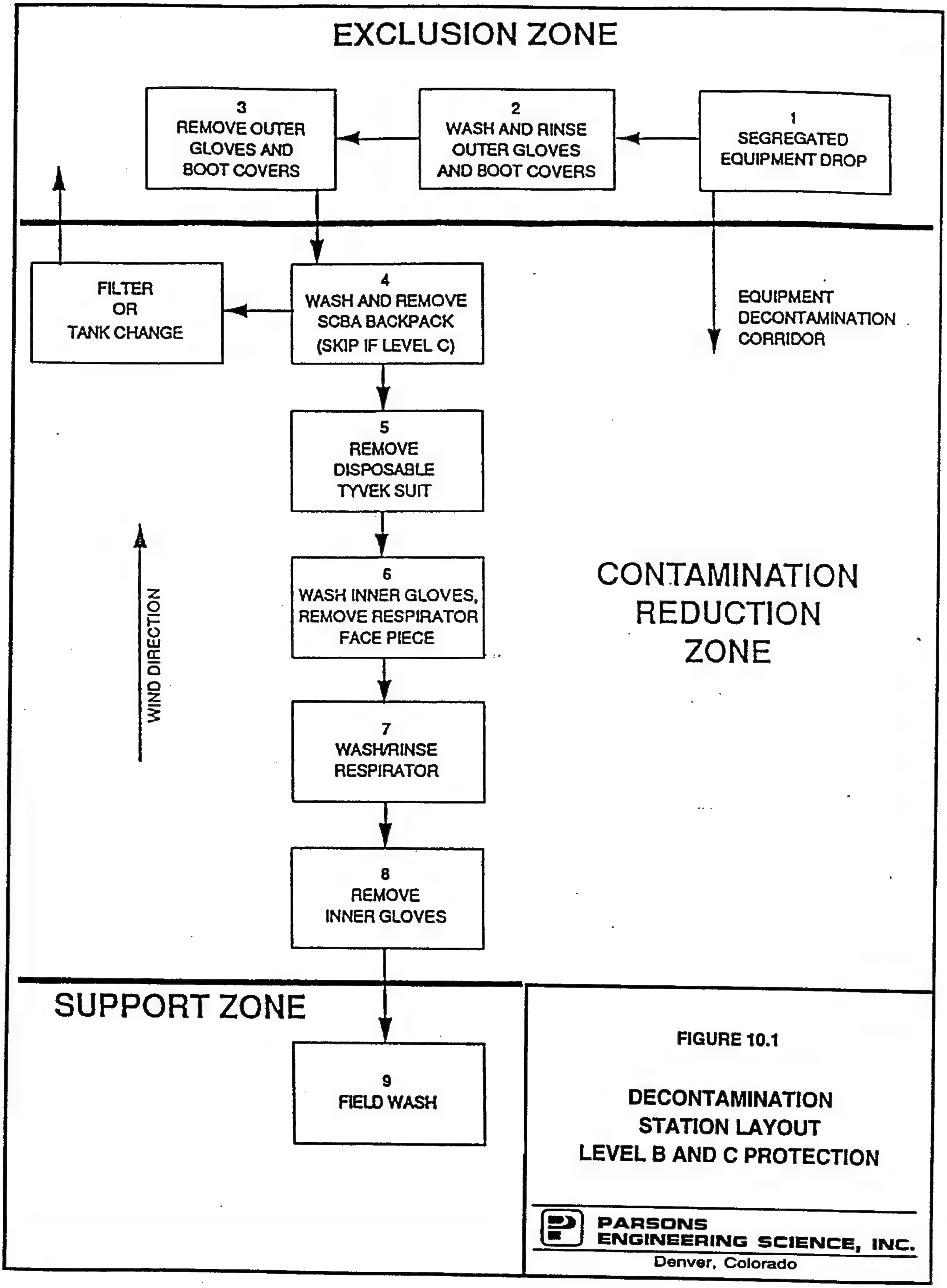


FIGURE 10.1

DECONTAMINATION STATION LAYOUT LEVEL B AND C PROTECTION

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

- An eye wash station.

10.2 DECONTAMINATION OF EQUIPMENT

Decontamination of drilling rigs will be conducted at a location onsite where the rinse water can be collected. High-pressure steam cleaning of drilling rigs will be necessary prior to the start of the drilling operation, between borehole locations, and before the drill rig leaves the project site. All sampling equipment will be decontaminated prior to use, between samples, and between sampling locations. Sampling equipment should be thoroughly washed with detergent, followed by clean water rinse, solvent (methanol) rinse, and a distilled water rinse. Adequate time will be allowed for solvent evaporation.

SECTION 11

AIR MONITORING EQUIPMENT USE AND CALIBRATION PROCEDURES

11.1 PHOTOVAC TIP AIR ANALYZER

To use the Photovac TIP® press the power switch, unlock ZERO and SPAN controls by turning locking rings clockwise. Set span control to 5, lock span control by turning locking ring counter-clockwise. Allow TIP® to sample clean air. Adjust zero control until display reads 0.00. Lock zero control by turning locking ring counterclockwise observe sample concentration changes. Turn TIP® off.

The TIP® is used as a direct-reading instrument in conjunction with the span gas kit. In order to calibrate your TIP® press the power switch, unlock the zero and span controls by turning locking rings clockwise. Set span control to 5. Allow TIP® to sample clean air. Adjust zero control until display reads 0.00. Connect bag of span gas to the TIP® inlet. Adjust span control until display indicates the span gas concentration (usually 100 ppm). Disconnect span gas bag. Sample clean air again and readjust zero control until displays reads 0.00. Lock zero control in. Sample span gas again, and readjust span control until display indicates the span gas concentration. Lock span control in. Observe sample concentrations. The concentration of total ionizables is displayed in span gas equivalent units. Turn TIP® off.

11.2 HNu® PHOTOIONIZATION DETECTOR

To use the HNu® connect the probe to the instrument by matching the alignment slot in the probe connector to the key in the 12-pin connector on the control panel, twist the probe connector until a distinct snap and lock is felt. Turn the function switch to battery check position. The needle should read within or above the green battery arc on the scale plate. If the needle is in the lower position of the battery arc, the instrument should be recharged before use. If the red light comes on, the battery should be recharged. Next, turn the functions switch to the on position, and the instrument is ready to take direct air readings.

11.3 TRACETECHTOR® TOTAL VOLATILES ANALYZER

The Tracetechtor® is used for measuring total volatile hydrocarbon gas levels. The ON/OFF switch is located on the front of the case. Once the unit is turned on, wait a few seconds for the readings to stabilize. Check the battery charge and the alarms before using the instrument.

To calibrate the instrument with span gas, attach the flow regulator to the calibration gas cylinder. Fill a 3-liter Tedlar bag with calibration gas. Connect the instrument to the Tedlar bag using Tygon tubing and wait for the readings to stabilize. Using a small jeweler's screwdriver, adjust the span gas pot on the side of the instrument to obtain a steady reading which corresponds with the calibration gas concentration. Remove the calibration lines and let the instrument run for a full minute to flush out any excess span gas. Check readings; the combustible sensor should now be reading zero in fresh air.

11.4 SENSIDYNE, OR DRÄGER®, COLORIMETRIC GAS ANALYSIS TUBES (BENZENE SPECIFIC)

Drãger® tubes can be used to give an instantaneous reading of various organic compounds. Their aim is to determine very small concentrations of a compound in the shortest amount of time. To sample with a Drãger® tube use the Drãger® or Sensidyne® bellows pump and select the appropriate tube (for example, a tube marked benzene to look for benzene). Break off both ends on the pump's break-off plate. Insert the tube into the pump head (the tube should be inserted with the arrow pointing towards the pump). There is a given number of suction strokes for each tube/compound. Each box of tubes will have instructions for how many suction strokes are required for that compound.

APPENDIX A

EMERGENCY CONTACTS

APPENDIX A

EMERGENCY CONTACTS

In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) should be made from a list similar to this which will be prepared in the health and safety plan addenda. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response teams.

<u>Contingency Contacts</u>	<u>Phone Number</u>
Nearest phone located at the work site	____________
Base Fire Department	____________
Site Contact	____________
Site Medical Services	____________
Site Emergency Number	____________
Security Police	____________
<u>Medical Emergency</u>	
Hospital Name	____________
Hospital Phone Number	____________
Ambulance Service (Also Police)	____________
Airlift helicopter	____________

Directions or Map to the Hospital

<u>ES Contacts</u>

ES Project Manager Doug Downey	(303) 831-8100 (w) (303) 670-0512 (h)
ES Health and Safety Manager Timothy Mustard	(303) 831-8100 (w) (303) 450-9778 (h)
Corporate Health and Safety Manager Edward Grunwald	(404) 325-0770 (w)

APPENDIX B

PROJECT HEALTH AND SAFETY FORMS

APPENDIX B

SITE/BASE SPECIFIC TRAINING RECORD

On this date ______________ the following individuals were provided site specific training in accordance with OSHA regulations contained in 29 CFR 1910.120 (e). This individuals have also read and are familiar with the contents of the site specific health and safety plan.

Name (print) Employee No. Signature

1.____

2.____

3.____

4.____

5.____

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

Instructions: This form is to be completed by each person to work on the subject project work site and returned to the safety manager.

I have read and agree to abide by the contents of the Health and Safety Plan for the following project:

____

____

____
Signed

____
Date

RETURN TO:

Office Health and
Safety Representative
Engineering-Science, Inc.
1700 Broadway, Suite 900
Denver, CO 80290

SCBA LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	SCBA#	Satisfactory (Yes/No)	Check-Out Initials	Date Cleaned

SCBA Performance Comments:

Project H&S Officer
or
ES Project Manager

Date

Return to Office Health and Safety Representative
at the completion of field activities.

AIR PURIFYING RESPIRATOR LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	Cleaned and Inspected Prior To Use (Initials)	Cartridges Changed Prior to Use (Yes, No, N/A)	Total Hours on Cartridge

Project H&S Officer
or
ES Project Manager

Date

Return to the Office Health and Safety Representative
at the Completion of field activities.

SAR

RESPIRATOR LOG

SITE:

LOCATION:

DATES OF INVESTIGATION:

User	Date of Use	SAR#	Satisfactory (Yes/No)	Check-Out Initials	Date Cleaned

SAR Performance Comments:

Project H&S Officer or ES Project Manager — Date

Return to Office Health and Safety Representative at the completion of field activities.

PARSONS ENGINEERING SCIENCE COMPANIES

ACCIDENT REPORT FORM

Project: ______________________________

EMPLOYER

1. Name: ______________________________
2. Mail Address: ______________________________
   (No. and Street) (City or Town) (State and Zip)
3. Location (if different from mail address: ______________________________
   ____

INJURED OR ILL EMPLOYEE

4. Name: ______________________________ Social Security No.: ______________
   (first) (middle) (last)
5. Home Address: ______________________________
   (No. and Street) (City or Town) (State and Zip)
6. Age: ________ 7. Sex: male ( ) female ( )
8. Occupation: ______________________________
   (specific job title, not the specific activity employee was performing at time of injury)
9. Department: ______________________________
   (enter name of department in which injured person is employed, even though they may have been temporarily working in another department at the time of injury)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident of exposure: ______________________________
    (No. and Street) (City or Town) (State and Zip)
11. Was place of accident or exposure on employer's premises? Yes ( ) No ( )
12. What was the employee doing when injured? ______________________________
    (be specific--was employee using tools or equipment
    ____
    or handling material?)
    ____
13. How did the accident occur? ______________________________
    (describe fully the events that resulted in the injury or occupational illness.
    ____
    Tell what happened and how. Name objects and substances involved. Give details on all factors that led to
    ____
    accident. Use separate sheet for additional space).
14. Time of accident: ______________________

15. ES WITNESS TO ACCIDENT ______________________________
(Name) (Affiliation) (Phone No.)

____
(Name) (Affiliation) (Phone No.)

____
(Name) (Affiliation) (Phone No.)

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

16. Describe injury or illness in detail; indicate part of body affected:

____

____

17. Name the object or substance that directly injured the employee. (for example, object that struck employee; the vapor or poison inhaled or swallowed; the chemical or radiation that irritated the skin; or in cases of strains, hernias, etc., the object the employee was lifting, pulling, etc.).

____

____

18. Date of injury or initial diagnosis of occupational illness: ______________
(date)

19. Did the accident result in employee fatality? Yes ( ) No ( )

20. Number of lost days ____/restricted workdays ____ resulting from injury or illness?

OTHER

21. Name and address of physician:______________________________
(No. and Street) (City or Town) (State and Zip)

22. If hospitalized, name and address:______________________________
(No. and Street) (City or Town) (State and Zip)

Date of report: ____________ Prepared by:______________________

Official position:______________________

"NEAR MISS" INCIDENT INVESTIGATION REPORT FORM

1) Project name and number:________________________________

2) "Near miss" location:________________________________

3) Incident date and time:________________________________

4) Personnel present (optional):________________________________

5) Describe incident:________________________________

6) What action or condition contributed to incident?________________

7) What action was taken or suggested to prevent reoccurrence?________________

8) Comments________________________________

9) Date of report________________ Prepared by________________

10) Office health and safety representative review:

________________________ ________________________

Signature Date

ENGINEERING-SCIENCE, INC.

FIELD EXPERIENCE

DOCUMENTATION FORM

OSHA requires (29CFR1910.120(e)) that personnel involved in hazardous waste operations have 40-hours of initial training and a minimum of three days field experience working under the direction of a trained and experienced supervisor. This form serves to document the three days of additional field training/experience.

Employee Name:____

Employee Number (or Social Security No.):____________________

Project Name(s):____

Project Number(s):______________________________________

Dates of Field Training:__________________________________

Summary of Activities Performed:__________________________

____

____

Levels of Respiratory Protection Used:______________________

____

Comments:

Field Supervisor Signature:_______________________________

Date:____

Return this form to the Office Health and Safety Representative

APPENDIX D
SITE-SPECIFIC HEALTH AND SAFETY PLAN ADDENDUM

ADDENDUM TO

THE PROGRAM HEALTH AND SAFETY PLAN FOR EXTENDED BIOVENTING AT OLD EGLIN MAIN FIRE TRAINING AREA

AT

EGLIN AIR FORCE BASE FLORIDA

October 1997

Prepared by:

Parsons Engineering Science, Inc.
57 Executive Park South, NE, Suite 500
Atlanta, Georgia 30329

REVIEWED AND APPROVED BY:

	Name	Date
Site Manager	Steve A. [illegible]	10/30/97
Corporate Health & Safety Manager	Edward [illegible]	10/30/97

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D1.0 INTRODUCTION

This addendum modifies the existing program health and safety plan entitled *Program Health and Safety Plan for Extended Bioventing* (Parsons Engineering Science, Inc., 1995) for completing remediation monitoring and for designing and implementing full-scale bioventing systems at numerous United States Air Force (USAF) installations.

Under contract number F41624-92-D-8036, Delivery Order (DO) 17, Air Force Center for Environmental Excellence (AFCEE), Technology Transfer Division (ERT), Brooks Air Force Base (AFB), Parsons Engineering Science, Inc. (Parsons ES) was retained to transition new and existing bioventing pilot-scale systems toward either site closures or toward expansion into full-scale systems. Project options under DO 17 include one additional year of testing for existing bioventing systems; closure soil sampling; completion of initial bioventing tests at new sites; and design and installation of multiple-vent well, full-scale systems.

This addendum also modifies the existing program health and safety plan entitled *Health and Safety Plan for Risk-Based Remediation Demonstrations* (Engineering-Science, Inc., 1994) for site investigations at fuel-contaminated sites at various USAF installations. Under contract F41624-93-C-8044, AFCEE, ERT, Brooks AFB, Parsons ES was retained to assist the USAF in developing and implementing a practical, risk-based approach to fuel-spill remediation.

This addendum to the program health and safety plans was prepared to address the upcoming tasks at Eglin Air Force Base (AFB), Florida. Included or referenced in this addendum are the scope of services, site-specific description and history, project team organization, hazard evaluation of known or suspected chemicals, evaluation of physical hazards, emergency response procedures and information, personal protective equipment, decontamination procedures, site control measures, and health and safety procedures required for the proposed work. All other applicable portions of the program health and safety plans remain in effect.

Site-specific health and safety briefings will be conducted daily prior to the commencement of field activities to communicate the site-specific hazards, activities, and procedures to all field personnel. Documentation of training and briefings, including agenda and signatures of attending personnel, will be maintained onsite.

D2.0 SCOPE OF SERVICES

The scope of services to be completed by Parsons ES under the extended bioventing contract will involve the installation of a full-scale bioventing system for *in situ* treatment of fuel-contaminated soils at IRP Site FT-28, Eglin Main Base Old Fire Training Area (Old Eglin FTA). The extended bioventing system will include the existing air injection vent well (VW), and will involve the construction of four additional VWs, three new vapor monitoring points (MPs), soil and soil gas characterization, *in situ* respiration tests, and the installation of a new blower system for air injection. Well and monitoring point construction will be accomplished with an auger-equipped drilling rig.

D3.0 SITE DESCRIPTION AND HISTORY

The site description and history for the bioventing tasks are outlined in the work plan entitled *Interim Corrective Action Work Plan for Expanded Bioventing System at Eglin Main Base Fire Training Area, Eglin Air Force Base, Florida* (Parsons ES, 1997).

The old Eglin FTA is a former fire training facility located west of the north-south runway and north of Taxiway Number 6 within the main base of Eglin AFB. The old Eglin FTA was used from the 1950s to the late 1970s or early 1980s to train personnel in the suppression of fires associated with aircraft accidents.

D4.0 PROJECT TEAM ORGANIZATION

The project team assigned to the extended bioventing activities at Eglin AFB are identified below.

Mr. John Ratz	Project Manager
Mr Steve Ratzlaff	Site Manager
Mr. Steve Ratzlaff	Site Health and Safety Officer
Mr. Ralph Armstrong	Eglin AFB Contact
Major Ed Marchand	AFCEE/ERT Contact

D5.0 HAZARD EVALUATION

D5.1 CHEMICAL HAZARDS

Potential chemical hazards are addressed in the program health and safety plan. Site-specific hazards are identified below.

The primary contaminants at the old Eglin FTA are and the associated petroleum hydrocarbon constituents benzene, toluene, ethylbenzene, and xylenes (BTEX). A number of semi-volatile organic compounds, pesticides, and metals have been detected in the surface and subsurface soils at the site. However, the detected concentrations in soil do not present an inhalation or respirable dust health hazard.

Health hazard qualities for these compounds are presented in Table 5.1 of this addendum. If additional compounds are discovered during the course of field activities, this health and safety plan addendum shall be amended and pertinent information about the compounds will be communicated to all field personnel.

Protection standards for chemical hazards are located in Section 7 of the program health and safety plans. Additional requirements are provided below.

To avoid employee contamination and exposures above the permissible exposure limits (PELs), personnel involved in the trenching operations under the extended bioventing contract will not enter the trench unless the trench is less than 4 feet in depth. If such an entrance is absolutely necessary, vapor concentrations will be closely monitored and ventilation may be necessary to ensure that vapor concentrations are below appropriate levels, as discussed in Section 7.1 of this addendum.

As a general precaution, the breathing zone will be closely monitored for all personnel in the vicinity of the trench, and the area around the trenching machine/backhoe will be monitored for flammable atmospheres.

D5.2 PHYSICAL HAZARDS

Potential physical hazards at this site include risks associated with auger drilling and trenching activities; electrical equipment; heavy equipment; motor vehicles; overhead and underground utilities; slip, trip, and fall hazards; noise; and heat stress.

Safe work practices related to the site physical hazards are contained in Sections 5 and 9 of each program health and safety plan. Additional requirements are provided below.

D5.2.1 Motor Vehicles and Heavy Equipment

In addition to the information provided in Section 5.2.1 of the extended bioventing program health and safety plan, the following precautions will also be taken.

TABLE D5.1 HEALTH HAZARD QUALITIES OF HAZARDOUS SUBSTANCES OF CONCERN

Compound	PEL [a] (ppm)	TLV [b] (ppm)	IDLH [c] (ppm)	Odor Threshold[d] (ppm)	Ionization Potential[e] (eV)	Physical Description/Health Effects/Symptoms
Benzene	1 (29 CFR 1910.1028) [f]	10	500	4.7	9.24	Colorless to light-yellow liquid (solid<42°F) with an aromatic odor. Eye, nose, skin, and respiratory system irritant. Causes giddiness, headaches, nausea, staggered gait, fatigue, anorexia, exhaustion, dermatitis, bone marrow depression, and leukemia. Mutagen, experimental teratogen, and carcinogen.
Ethylbenzene	100	100	800	0.25-200	8.76	Colorless liquid with an aromatic odor. Irritates eyes, skin, and mucous membranes. Causes dermatitis, headaches, narcosis, and coma. Mutagen and experimental teratogen.
Toluene	100	50 (skin)[i]	500	0.2-40 [j]	8.82	Colorless liquid with sweet, pungent, benzene-like odor. Irritates eyes and nose. Causes fatigue, weakness, dizziness, headaches, hallucinations or distorted perceptions, confusion, euphoria, dilated pupils, nervousness, tearing, muscle fatigue, insomnia, skin tingling, dermatitis, bone marrow changes, and liver and kidney damage. Mutagen and experimental teratogen.
Xylene (o-, m-, and p-isomers)	100	100	900	0.05-200 [j]	8.56 8.44 (p)	Colorless liquid with aromatic odor. P-isomer is a solid <56°F. Irritates eyes, skin, nose, and throat. Causes dizziness, drowsiness, staggered gait, incoordination, irritability, excitement, corneal irregularities, conjunctivitis, dermatitis, anorexia, nausea, vomiting, abdominal pain, and olfactory and pulmonary changes. Also targets blood, liver, and kidneys. Mutagen and experimental teratogen.

a/ PEL = Permissible Exposure Limit. OSHA-enforced average air concentration to which a worker may be exposed for an 8-hour workday without harm. Expressed as parts per million (ppm) unless noted otherwise. PELs are published in the *NIOSH Pocket Gu* California) may have more restrictive PELs. Check state regulations.
b/ TLV = Threshold Limit Value - Time-Weighted Average. Average air concentration (same definition as PEL, above) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH), *1994-1995 Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.*
c/ IDLH = Immediately Dangerous to Life or Health. Air concentration at which an unprotected worker can escape without debilitating injury or health effects. Expressed as ppm unless noted otherwise. IDLH values are published in the *NIOSH Pocket Guide to Chemical Hazards*, 1994.
d/ When a range is given, use the highest concentration.
e/ Ionization Potential, measured in electron volts (eV), used to determine if field air monitoring equipment can detect substance. Values are published in the *NIOSH Pocket Guide to Chemical Hazards*, June 1994.
f/ Refer to expanded rules for this compound.
g/ Based on exposure limits for petroleum distillates (petroleum naphtha).
h/ NA = Not available.
i/ (skin) = Refers to the potential contribution to the overall exposure by the cutaneous route.
j/ Olfactory fatigue has been reported for the compound and odor may not serve as an adequate warning property.

- All personnel working at and around the drill rig must be informed of the locations of the kill switches, in the event of an emergency.

- The kill switches must be tested daily prior to the start of field activities. A log of the testing must be maintained onsite. The limits of the swing radius of the backhoe must be marked on the ground with cones or boundary tape. Personnel will not enter this bounded area until the backhoe has been shut down, and the operator signals that it is acceptable to enter.

- When working near the backhoe, field personnel will maintain sight contact with the operator.

D5.2.2 Excavation Activities

As previously stated in Section 5.2.4 of the extended bioventing program health and safety plan, the location of underground utilities must be delineated in the area before intrusive activities can occur. A buried electrical line, which provides power to the existing blower system, is known to exist in the vicinity of the trenching activities. The exact location of this line must be determined before trenching activities can begin.

D5.2.3 Electrical Line Clearance

In addition to the information presented in the electrical hazards section (Section 5.2.5) of the extended bioventing program health and safety plan, extra precautions must be taken when drilling or using a backhoe in the vicinity of overhead power lines. The minimum clearance is 10 feet between heavy equipment and an overhead electrical line rated 50 kilovolts (kV) or less. For lines rated over 50 kV, the minimum clearance is 10 feet plus 0.4 inches for each kV over 50 kV.

D6.0 EMERGENCY RESPONSE PLAN

D6.1 EMERGENCY RECOGNITION AND PREVENTION

In amendment of the information presented in Section 6.2 of the bioventing program health and safety plan, emergency conditions are considered to exist if:

- Concentrations of combustible vapors reach or exceed 10 percent of the lower explosive limit (LEL).

D6.2 EMERGENCY INFORMATION

Listed below are the names and telephone numbers for medical and emergency services in the event of any situation or unplanned occurrence requiring assistance. For emergency situations, telephone or radio contact should be made with the site point of contact or site emergency personnel who will then contact the appropriate response team.

Contingency Contacts	Telephone Number
Fire Department	911
Security Police	911 or (904) 882-2000
Site Contact: Ralph Armstrong	(904) 882-7792 Ext. 214
AFCEE-ERT Contact: Major Ed Marchand	(210) 536-4364

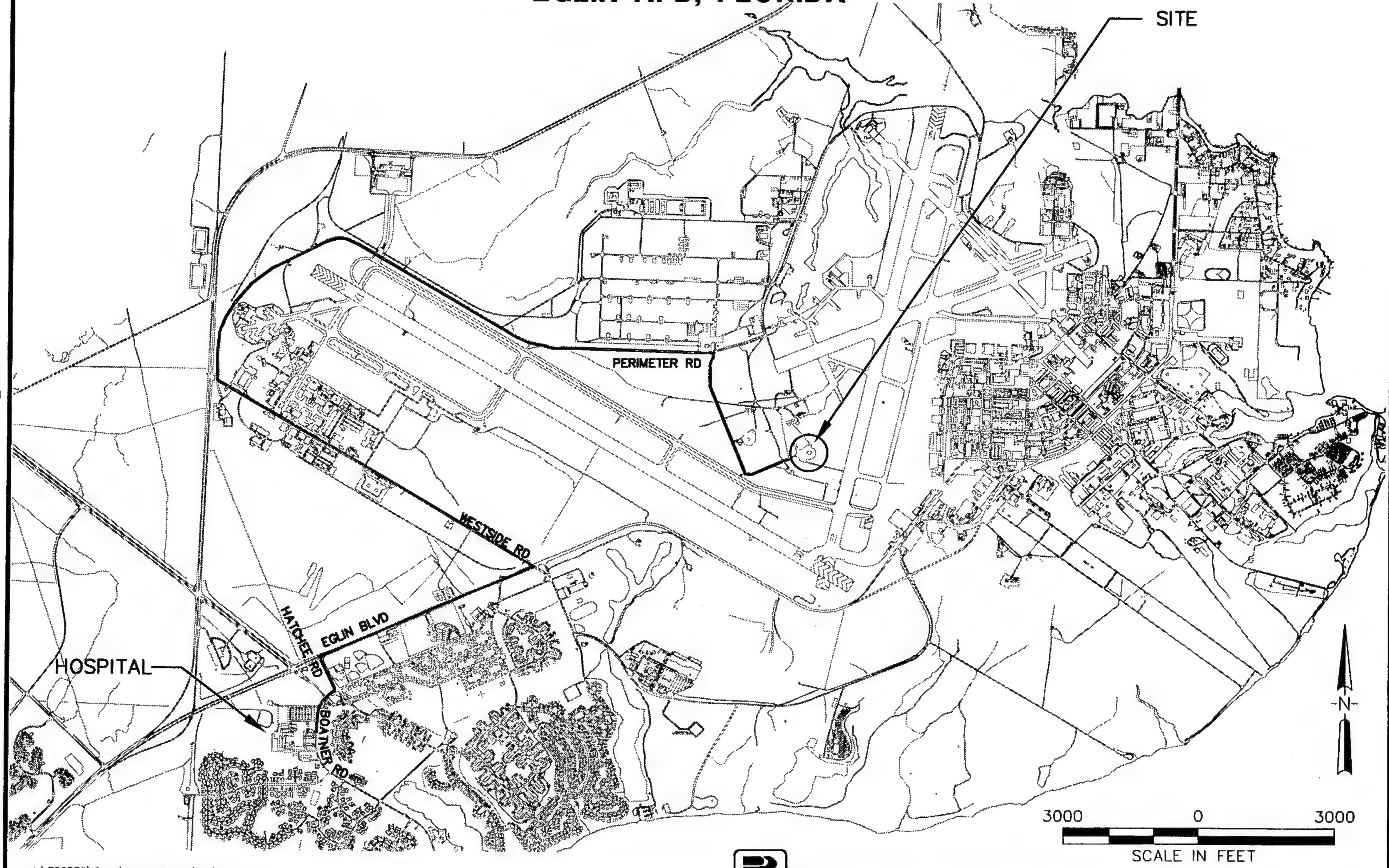
Medical Emergency

Hospital Name	Eglin Base Hospital
Hospital Address	Boatner Road (see Figure D6.1)
Hospital Telephone Number	(904) 883-8228 (Emergency Room)
Travel Time from Site:	10 to 15 minutes
Directions to Hospital	Proceed on the paved road leading from the site to the intersection with Perimeter Road. Turn left onto Perimeter Road and follow the perimeter road around to the intersection with Westside Road. Turn left onto Westside Road and travel approximately 1.5 miles to Eglin Boulevard. Turn right onto Eglin Boulevard and travel approximately one mile to Hatchee Road. Turn left onto Hatchee Road (just prior to the West Gate). Turn right onto Boatner Road. The Base Hospital will be on the right.

A list of emergency contacts must be posted at the site.

Figure D6.1

MAP TO HOSPITAL
EGLIN MAIN BASE OLD FTA (FT-28)
EGLIN AFB, FLORIDA



J:\726876\Cadd\siteloc2, 10/30/97 at 10:11

PARSONS ENGINEERING SCIENCE, INC.

PROJECT CONTACTS	Telephone Number
Parsons ES	
Steve Ratzlaff Parsons ES Site Manager	(404) 235-2361 (W) (770) 998-5172 (H)
John Ratz Parsons ES Project Manager	(303) 831-8100 (W) (303) 733-5582 (H)
Timothy Mustard, C.I.H. Program Health and Safety Manager (Denver)	(303) 831-8100 (W) (303) 450-9778 (H)
Ed Grunwald, C.I.H. Corporate Health and Safety Manager (Atlanta)	(404) 235-2300 (W) (770) 594-9760 (H)
Judy Blakemore Asst. Program Health and Safety Manager (Denver)	(303) 831-8100 (W) (303) 831-4028 (H)
Eglin AFB	
Ralph Armstrong	(904) 882-7792 x214
AFCEE	
Major Ed Marchand	(210) 536-4364

D7.0 LEVELS OF PROTECTION AND PERSONAL PROTECTIVE EQUIPMENT REQUIRED FOR SITE ACTIVITIES

D7.1 PERSONAL PROTECTIVE EQUIPMENT

The extended bioventing contract will use Figure 7.1, the fuels flow chart for selection of respiratory protection presented or described in the program health and safety plans for the individual projects and attached to this addendum. Respirators are not expected to be used during the installation of the expanded bioventing system, however, appropriate preparations will be performed should respiratory protection be necessary.

Air-purifying respirators will be used when fuel vapor concentrations in the worker breathing zone are between 25 and 50 meter units (mu) and as long as benzene concentrations in the worker breathing zone are less than 1 ppm. No respirator is necessary if fuel vapor concentrations in the worker breathing zone are less than 25 mu and benzene concentrations in the worker breathing zone are less than 1 ppm, unless otherwise directed by the site health and safety officer. Benzene concentrations will be measured with colorimetric tubes. Fuel vapor concentrations greater than 50 mu in the worker breathing zone will require the suspension of activities in the trench until the area is ventilated and the vapor concentrations in the worker breathing zone are reduced to under 50 mu, or until Level B, self-contained breathing apparatus and trained personnel are supplied. Field activities cannot be performed in Level B without the approval of the USAF and the Parsons ES corporate health and safety manager, Ed Grunwald.

All breathing zone readings and instrument calibrations must be documented in a field notebook or on a personal air monitoring data form. The time that personnel spend wearing respirators must also be documented in a field notebook, and respirator logs must be completed. Field personnel will be fit-tested prior to the commencement of field activities.

In accordance with Occupational Safety and Health Administration (OSHA) requirements, personal exposure monitoring will be performed periodically during the bioventing remediation activities, due to the potential for exposure. During trenching activities, benzene vapor monitoring badges will be worn, preferably for an 8-hour period, by the backhoe operator and the person performing breathing zone monitoring. A blank badge must also be submitted for laboratory analysis, along with the badges worn by personnel.

In amendment of the information presented in Section 7.1 of the both program health and safety plans, Nitrile gloves will be worn when handling contaminated equipment or samples.

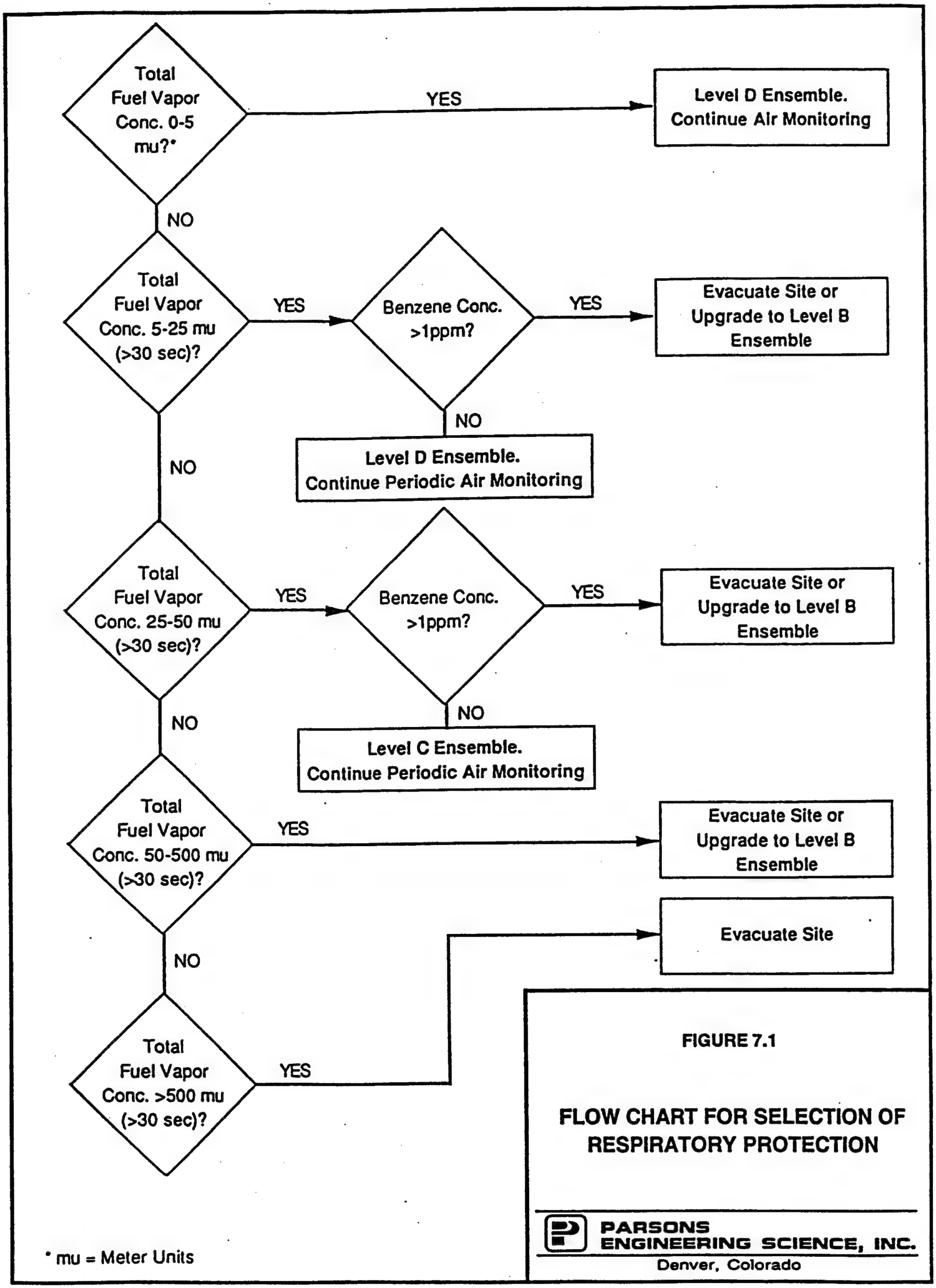


FIGURE 7.1

FLOW CHART FOR SELECTION OF RESPIRATORY PROTECTION

D8.0 DECONTAMINATION PROCEDURES

D8.1 PERSONNEL DECONTAMINATION PROCEDURES

The size and location of the decontamination station will be determined in the field prior to the commencement of field activities, and will be based on the level of personal protective equipment used and the site conditions, including topography, wind direction, and traffic patterns.

D9.0 SITE CONTROL

During intrusive activities, field personnel will remain in locations upwind from potential contamination. Wind direction indicators (e.g., tape, pin flags, etc.) will be used in the appropriate places and will be visible at all times.

APPENDIX E
DESIGN CALCULATIONS

PARSONS Calculation Sheet

Rev	By	Date	Ck	Date	Title Estimation of Radius of Influence for the Expanded Bioventing System to be Installed at Eglin AFB, Old Main FTA
	JWR	12/19/97	SAR	12/22/97	
					Author John Ratz Sheet 1 Of 4

From "Bioventing Principles and Practices Manual" Volume II, page 72:

$$R_I = \sqrt{\frac{Q(20.9\% - 5\%)}{\pi\ h\ k_o\ \theta_a}} \qquad (2\text{-}2)$$

where: R_I = radius of influence (ft)

Q = air flowrate (ft^3/day)

20.9 - 5% = oxygen %

k_o = oxygen utilization rate (%/day)

θa = air filled porosity (cm^3_{air}/cm^3_{soil})

h = aerated thickness (ft)

Example 2-3. Calculation of Radius of Influence: To calculate the radius of influence at Dover AFB, Equation (2-2) is used with the following parameters:

Q = 20 cfm (570 L/min) = 28,800 ft^3/day (820,800 L/day)
k_o = 4%/day
θ_a = 0.25
h = 20 ft (6.1 m)

$$R_I = \sqrt{\frac{\left(28{,}800\,\frac{ft^3}{day}\right)(20.9\% - 5\%)}{\pi(20\ ft)(4\%/day)(0.25)}}$$

Therefore, the radius of influence at this site is approximately equal to 85 ft (26 m).

PARSONS Calculation Sheet

Rev	By	Date	Ck	Date	Title
	JWR	12/19/97	SAR	12/23/97	Estimation of Radius of Influence for the Expanded Bioventing System to be Installed at Eglin AFB, Old Main FTA
					Author John Ratz — Sheet 2 Of 4

All data from pilot test year end testing event in July 1995, unless noted otherwise

Avg O_2 utilization rate at 5 feet below grade $= \frac{0.0061 + 0.031 + 0.035}{3} = .024\ \%/min$

Avg O_2 utilization rate at 26 feet below grade $= \frac{0.009 + 0.0049 + .0094}{3} = 0.0078\ \%/min$

Avg O_2 utilization rate at 39 feet below grade $= 0.0013\ \%/min$ (the only data available; from MPC-39 during the initial resp test in March 1994).

$$\frac{(.024\ \%/min)(13\ ft) + (.0078\ \%/min)(13\ ft) + (.0013\ \%/min)(13\ ft)}{39\ feet} = 0.011\ \%/min$$

$(0.011\ \%/min)(60\ min/hr)(24\ hr/day) = 15.9\ \%/day$ = depth-averaged K_0

θ_a = air-filled porosity = 0.03 in deeper soils at the site (26 feet bgs), or 0.16 in shallow soils. Avg θ_a = .095

Q = 35 cfm into one well $\times (60\ min/hr)(24\ hr/day) = 50{,}400\ ft^3/day$

h = 39 feet

$$R_I = \sqrt{\frac{(50{,}400\ ft^3/day)(15.9\ percent)}{\pi\,(39\ feet)(15.9\ percent/day)(0.095)}} = 66\ feet$$

TABLE 3.4
RESPIRATION AND DEGRADATION RATES
OLD EGLIN FTA (SITE FT-28)
EGLIN AFB, FLORIDA

Location-Depth (feet below ground surface)	Initial (March 1994) [a]			3-Month (September 1994) [b]			12-Month (July 1995) [e]		
	K_o (% O_2/min)	Degradation Rate (mg/kg/year) [b]	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)	K_o (% O_2/min)	Degradation Rate (mg/kg/year)	Soil Temperature (°C)
MPA (4.5 - 5')	0.0042	1,400	14.8	0.0018	620	NS	0.0061	1,100	28.4
MPA (25.5 - 26')	NS [c]	NC [d]	NS	0.00011	28	NS	0.0090	270	NS
MPA (38.5 - 39')	NS	NC	21.3	NS	NS	NS	NS	NC	21.8
MPB (4.5 - 5')	NS	NC	NS	0.0027	930	NS	0.031	5,600	NS
MPB (25.5 - 26')	0.0035	900	NS	0.00051	130	NS	0.0049	150	NS
MPC (4.5 - 5')	NS	NC	NS	0.011	3,800	NS	0.035	6,300	NS
MPC (25.5 - 26')	NS	NC	NS	0.0015	380	NS	0.0094	280	NS
MPC (38.5 - 39')	0.0013	220	NS	NS	NS	NS	NS	NC	NS

[a] Milligrams of hydrocarbons per kilogram of soil per year.
[b] Degradation calculation assumes moisture content of the soil is average of initial and final moistures.
[c] NS = Not sampled. [d] NC = Not calculated.
[e] Due to a delay in power installation, the extended test did not begin until July 6, 1994.
[f] Assumes moisture content of 5 foot depths equal to the average soil moistures determined at VW-3-5 and MPB-2-4 for July 28, 1995 soil samples. Soil moisture at 26 foot depths assumed to be equal to moisture content at MPA-33-34 collected on October 20, 1995.

3of4
12/19/97

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EGLIN AFB - Eglin Main Old Fire Training Area (FT-28) - FINAL

Biodegradation Rate Calculations | enter data | calculated data |

Formula: $K_b = K_o \times 1/100\% \times A \times D_o \times C$ Where:

K_b = fuel biodegradation rate
K_o = O_2 utilization rate (%/min.)
A = volume of air/kg soil
D_o = O_2 dens 1340 mg/L
C = Carbon/O_2 ratio for hexane mineralization = 1/3.5

Solving for 1 L of soil:

			Units						
Monitoring Point:				MPA-S(5')	MPA-M(26')	MPB-S(5')	MPB-M(26')	MPC-S(5')	MPC-M(26')
Oxygen util. rate	K_o =		%/min.	0.00610	0.00900	0.03100	0.00490	0.03500	0.00940
Moisture content [a]	w =		%	15.2	18.4	15.2	18.4	15.2	18.4
Soil Type [b]				mixed grain sand,loose	mixed grain sand	mixed grain sand,loose	mixed grain sand	mixed grain sand,loose	mixed grain sand
Porosity:	n =			0.40	0.35	0.40	0.35	0.40	0.35
Unit weight (dry):	$= G * {}^{g}w * (1-n)$ =		g/cm^3	1.59	1.72	1.59	1.72	1.59	1.72
Void ratio:	$e = n/1-n$ =			0.67	0.54	0.67	0.54	0.67	0.54
Specific gravity:	G =	2.65		2.65	2.65	2.65	2.65	2.65	2.65
Void volume:	$V_v = n * 1\ L$ =		liters	0.4	0.35	0.4	0.35	0.4	0.35
Deg. of saturation:	$S_r = Gw/e$ =			0.6	0.9	0.6	0.9	0.6	0.9
Volume of water:	$V_w = S_r * V_v$ =		liters	0.24	0.32	0.24	0.32	0.24	0.32
Volume of air:	$V_a = V_v - V_w$ =		liters	0.16	0.03	0.16	0.03	0.16	0.03
Bulk density:	${}^{g}d + (V_w * {}^{g}w)$ =		kg/L soil	1.8	2	1.8	2	1.8	2
Air filled volume:	$A = V_a$/Bulk Density		L air/kg soil	0.089	0.015	0.089	0.015	0.089	0.015
	K_b =		mg TPH/ kg soil/ year	**1092**	**272**	**5552**	**148**	**6268**	**284**

$K_b = K_o * 1/100\% * A * D_o * C * 525{,}600$ min/yr

[a] Moisture: Moisture values for MPA-5, MPB-5, and MPC-5 assumed to be the average of 1-year moisture values at VW-3-5 and MPB-2-4. Moisture values at 26 foot depths are assumed to be equal to the moisture value at MPA-33-34 collected on October 20, 1995.

[b] Assume: Soil properties are specified from Table 1.4. (Ref. Foundation Engineering, Peck, Hanson, and Thornburn, John Wiley Press, 1974).

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12/19/95

4 of 4
12/19/97